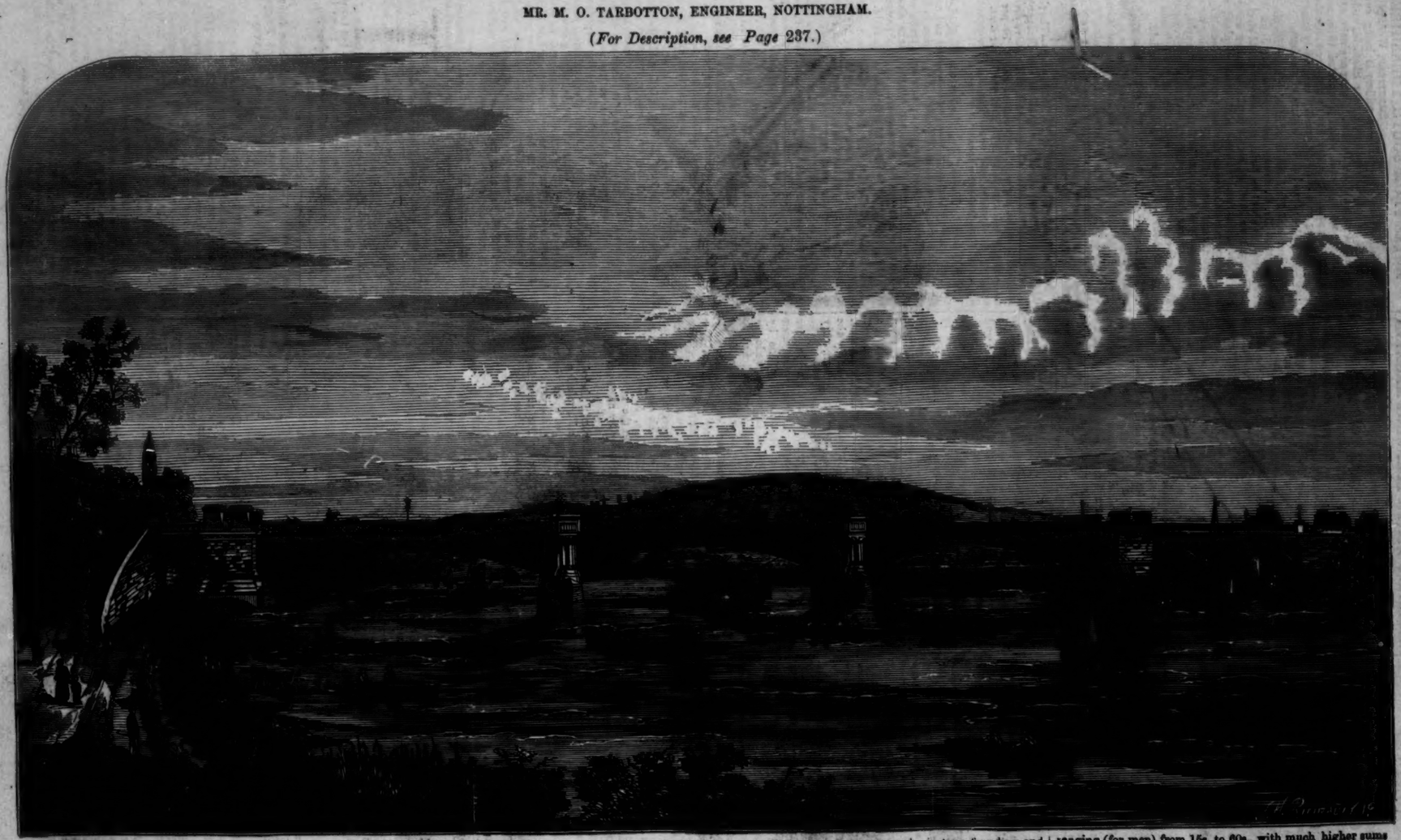
BRIDGE OVER THE RIVER TRENT AT NOTTINGHAM.

MR. M. O. TARBOTTON, ENGINEER, NOTTINGHAM.

(*For Description, see Page* 237.)



HOURS OF WORK.—In the early part of the present year Mr. Redgrave, factory inspector, ascertained the hours of labour of factory operatives in various parts of the North of England and in the metropolis. He reports the hours of work 60 per week in cotton, woollen, flax, jute, and silk manufactures; the wages are partly piece work and partly day work. He speaks of the hours of labour in print works as not necessarily restricted to 60 per week, and says that in fact they are generally rather in excess of that number, but in bleaching and dyeing works they must not exceed 60; the wages are paid partly by piecework and partly by day-work. In the iron manufacture Middlesbrough and Darlington report the average about 59 hours per week; and a like return comes from Manchester iron mills and foundries. Engineers, boiler, and agricultural machine makers in Manchester average less than 60 hours, but in Suffolk and Essex the full hours are worked; in locomotive engine-making at Glasgow the hours average about 57 per week. For hat and cap makers (London, Manchester, and Glasgow) the returns state 60 hours. In the metropolis the hours are 60 in oil mills and refineries and in lock and safe making; and 60 in cabinet making and upholstery, both in London and Manchester. In dressmaking in the metropolis the ordinary hours of work are stated to be from 8 a.m. to 8 p.m., but the average is less than 60 per week; in type-founding and in clockmaking, 58; in the building trade, 56½; in glass making, about 50; in envelope making (in which almost all are paid piecework) the hours, as a rule, are from 9 a.m. to 7 p.m., with intervals of an hour for dinner, and half-an-hour for tea. In lucifer-match making (Manchester) the hours are 60 per week. In the manufacture of tobacco and cigars the hours appear to be generally about 56 per week. In the boot and shoe manufacture at Leeds 59 for males and 54 for females. The number of hours worked in the principal Sheffield trades is stated to be about 58 per week. Mr. Redgrave gives a list of average wages earned in Sheffield, ranging (for men) from 15s. to 60s., with much higher sums for head rollers and head puddlers, but all these rates are on the supposition that a full week is worked. He has to state that there are in Sheffield a very large number of small masters, who, perhaps, are not always able to supply work to their men during the first day or two of the week; and a still larger number of operatives decline to work on Monday, and very often on Tuesday, and prefer the minimum of work equal to providing the bare necessaries of life. The returns asked for by Mr. Redgrave were given with great readiness and are of great interest, giving as they do, so clear an insight into the condition of labour in its various branches.

NOTES FROM PARIS.

Paris, Oct. 9, 1871.

The Solidification of Petroleum.

We extract the following from the *Journal de l'Eclairage au Gaz*, in reference to a new process:

"It consists in a means of solidifying petroleum and its volatile parts. In this condition the oil is subject to none but the most trifling evaporation. Even in case of fire there remains no fear of the terrible effects of the liquid flames spreading themselves on all sides, in an inextinguishable fire. Solidified by the new process, the mass of petroleum burns without liquefying. The petroleum is submitted to a novel process, which reduces it to its primitive state without its losing any of its lighting qualities, or without augmenting the price. The cost of the operation is compensated by the perfect preservation of the petroleum."

We leave to the author of the above all the responsibility of his somewhat startling statement, but we will place before our readers any results that may arise from the new process.

Duprez's Planimeter.

There have been constructed many different forms of planimeters—that is to say, instruments for ascertaining the area of a curved or irregular figure by tracing the perimeter by aid of a style, but engineers have often to find out the centre of gravity of such a figure, and also its moment of inertia. If the equation of the figure is put under the form $y = F(x)$ one can find mechanically $\int y\,dx$, and must work either by calculation or graphically to find $\int y^2\,dx$ and $\int y^3\,dx$.

M. Duprez, whose name we lately mentioned as the inventor of the ingenious dynamometric indicator, has just presented to the Academy a very simple instrument for determining the three integrals of any curved form. The instrument is composed of a rod carrying a pointer at one end, with which one follows the contour of the figure, and at the other end a roller, which is carried on the paper, and the axis of which is always horizontal, and makes, with a fixed straight line taken for the axis of x, a variable angle. The rod is guided by one of its points along this axis. The roller carries a little drum, the circumference of which is divided into 100 equal parts; a vernier gives the tenths of subdivision, and a little disc, connected with the roller by an endless screw, effects the adding up of the revolutions of the roller.

If l be called the length of the rod between the style, and the point which is guided along the axis of x α and β, the angles made respectively with this axis, by the positions of the rod, and that of the axis of the roller, and by φ the linear arc which the roller traverses on the paper, M. Duprez shows in his demonstration that if the style leaving any point of the circle, and returns to its point of departure, always following the perimeter, the value of the arc φ is equal to

$$\int dx \sin \beta,$$

the integral being extended to the entire contour. Now, by connecting with gearing the rod of the instrument and the axis of the roller, one can easily establish between the angles α and β, one of the relations,

$$1st.\ \beta = \alpha;\quad 2nd.\ \beta = 2\alpha + \frac{\Pi}{2};\quad 3rd.\ \beta = \Pi\alpha$$

whence:

1. $\sin \beta = \frac{y}{l}$ and $\int dx \sin \beta = \frac{\int y dx}{l} + c.$

2. $\sin \beta = \cos 2\alpha = 1 - 2\sin^2 \alpha = 1 - \frac{2y^2}{l^2}$ and

$$\int dx \sin \beta = x - \frac{2\int y^2 dx}{l^2} + c.$$

3. $\sin \beta = \sin^3 \alpha = \frac{3}{4}\sin \alpha - \frac{1}{4}\sin^3 \alpha$ and $\int dx \sin \beta = \frac{3\int y dx}{l} - \frac{4\int y^3 dx}{l^3} + c.$

From these three relations one concludes in calling φ_1, φ_2, and φ_3, the three readings of the arc φ made in each of the three cases,

$$\int y dx = \varphi_1 \frac{l}{2},\quad \int y^2 dx = \frac{\varphi_2 l^2}{3},\ \text{and}$$

$$\int y^3 dx = \frac{l^3}{4}(3\varphi - \varphi_3).$$

The first of these three cases gives the area of the figure, the second, its centre of gravity, and the third, the moment of inertia in relation to the line taken for the axis of x. It is easy to see that by similar means one could obtain the integrals of the form $\int y^m\,dx$, but the three first are useful in practice, and they can be often employed in calculating the resistance of materials.

The Honduras Interoceanic Railway.—A telegram has been received by Messrs. Waring Brothers and M'Candlish, the contractors, from Mr. Turner, their agent, announcing the entire completion of the first section of the Honduras Interoceanic Railway, on the 26th ult. It is stated that all possible progress is being made with the two remaining sections, and that the workmen hitherto engaged on the first section will now be employed on the other portion of the line.

LISMANN'S PLATE FLANGING MACHINE.

We illustrate, on page 232, a machine lately designed and constructed by Mr. A. Lismann, of Munich, which has for its object the bending, flanging, and shaping of plates, and to supersede the hand labour now employed in these and similar processes. This machine and its modification is especially adapted to the thinning of the edges of plates of any form and to bending and flanging them; also to rolling tubes, shafts, or any bodies, the forms of which are produced by a revolution around their axes. The main feature of the apparatus consists in the form of the rollers which rotate in opposite directions, and are provided with screw threads as shown. These rollers are of course formed in various ways according to the work they are intended for, and are set at various angles and in different positions for thinning and bending plates, rolling tubes, &c. Figs. 1, 2, 3, and 4, show a machine adapted for forming tubes, shafts, &c. In this machine the main shaft, a, gives a movement in similar directions to the three axles of the rollers, d, d, by means of the inner gearing on the wheel, b, Fig. 4, and the three pinions, c, c, c. At the ends of the shafts, d, d, the screw rollers are placed, the threads on which are formed according to the work to be done. The shafts are placed at equal distances apart, so as to form with each other an equilateral triangle, Fig. 2. Below the frame carrying the rollers is a sliding table, e, which is moved to and fro by means of a screw; upon this carriage are fixed the adjustable sliding brackets, f and g, between which a pattern or model to which the object to be rolled is to be formed, is attached. On the other side is a third bracket, i, also adjustable, and used to support the body that has to be rolled into shape. This bracket is provided with a spring or weight, which always presses against the metal, being shaped so as to keep it in contact with the rollers. The regulating rollers, k, k, are mounted on the shaft, d, revolve always upon the surface of the pattern, and thus measure the exact distance apart of the screw rollers, which, therefore, bear only upon the metal acted upon as the guide rollers permit. In rolling a tube a mandril, h, is mounted between the brackets, i, g, and the plate is wrapped by the rollers around the mandril. Or in rolling a solid body, the form is regulated by the action of the rollers which, bearing upon the pattern, vary according to the relative positions of the rollers.

Figs. 5 to 10 show the construction of a machine for stretching, bending, or flanging plates. In this arrangement the screwed rollers are driven in opposite directions by gearing as shown. The bearings of the upper axle are carried by a frame which turns around a pin fastened to the top of the plummer block of the lower shaft (Figs. 5 and 10). The distance between the two axles or rollers may be regulated by the screw gear either on the front or back standard of the frame; the adjustment on the rear pillar is chiefly used for placing the two shafts parallel to each other. If a circular plate is operated on, it is supported at the centre by a frame, a, which can be moved to and fro by a screw working in the slide, b, which is connected with the crowbar, c, carried in the bearings, d, e; these bearings are movable horizontally by means of a rack and pinion.

If the plate has to be stretched around the edge, it is fastened in the frame, a, and adjusted with relation to the rollers of the slide, b; pressure is then put upon the rollers and the edge of the plate is extended. In order to remove the marks made upon the plate by the threads of the rollers, the operation is resumed and the lines of contact are then made to cross each other and the surface becomes smooth. To bend the side of a plate, the edge is gradually brought between the rollers, and the carriage on which it is supported is raised.

In rolling flanges, on a cylinder, for example, the cross bar, b, shown in Figs. 1 to 4, is removed, and the part, Figs. 5 and 6, is substituted. A pressure roller, f, is fastened to a vertical shaft on the slide, b, which carries instead of the frame, a, a movable head with a face plate provided with sliding blocks that are pressed against the revolving cylinder by means of a right and left-handed screw. The edge of the cylinder to be flanged is then brought between the screw rollers, and the position of the carriage on which the cylinder is mounted is gradually adjusted until the flanging is completed.

The experience which has been obtained with this bending machine (some other example of which we may take an early opportunity of publishing), has been found satisfactory, and the testimony of Mr. H. K. Ludewig, Professor at the Munich Polytechnic School, Mr. Krämer, chief locomotive superintendent of the Bavarian Eastern Railway, and others, is extremely favourable.

"Train up a Child, &c."—An American contemporary of ours publishes the following:—"An ingenious toy for children is a small steamer which explodes by machinery, scattering the passengers in every direction."

The P. and O.—Much satisfaction has been evoked in Sydney, New South Wales, by a statement that the Peninsular and Oriental Company, with a view to the improvement of the present mail service between England and Australia, had determined to place their fine ships Pera and Ceylon on the line between Galle and Sydney. These vessels will carry a large number of passengers and perform their work with great expedition.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

New Colliery near Sheffield.—A colliery is being sunk at Wincobank Wood, Grimesthorpe, near Sheffield, under the management of Mr. John Denton, mining engineer, to work the Silkstone seam of coal, which is expected to be reached at no great depth. No water has as yet been encountered, the shaft being on a hill side, and it is sanguinely anticipated that none will be found at the bottom of the shaft.

New Iron and Steel Works at Heeley, near Sheffield.—It is stated that Mr. G. Brown, a nephew of Sir John Brown, of Sheffield, is about to build extensive iron and steel works at Heeley, near Sheffield, on the land now under water as a mill dam. It is further stated that these proposed works will occupy some twelve or thirteen acres. Messrs. Flockton and Abbott, architects, of Sheffield, are advertising for a very large quantity of bricks, to be delivered on the spot, so that it would appear that operations are shortly to be commenced. The site is close to the Heeley Station of the Midland Railway, and about two and a half miles from Sheffield.

The Reservoir of the Sheffield Water Works.—The Strines reservoir of the Sheffield Water Works Company, which is situate about eight miles from that town, has just been completed, and is now, I am informed, being gradually filled with water. The same company has another very large reservoir in course of construction at Damflask, in the same valley, but some miles nearer Sheffield.

Dividend of the Sheffield Gas Light Company.—The thirty-third ordinary meeting of the Sheffield Gas Company will be held on October 20th. The A stock will receive dividend at the rate of 10 per cent. per annum; the B 10 per cent. and the new 10*l.* shares, with 2*l.* paid up, 7½ per cent. The company are about to build new offices and show-rooms near the site of their present offices.

New Mineral, Timber, &c., Station at Sheffield.—The Midland Railway Company have just completed and opened for public use a new mineral, timber, &c., station in Pond-street, Sheffield, in order to accommodate that traffic on the south side of the town. The same company have also decided to erect a bridge for the accommodation of passengers from the park district to their new station at Sheffield.

New Mode of Constructing Furnaces.—The method of constructing furnaces invented and patented by Mr. James M. Stanley, formerly of the Midland Iron Works, Sheffield, has been adopted in a good many instances at Sheffield, and the method is attracting some attention. The results hitherto attained are stated to be excellent, these furnaces, by the aid of a steam jet and improved construction, being fully heated in about 20 minutes. There is also asserted to be a greater economy in fuel.

Opening of a New Coal Seam near Rotherham.—A new colliery is being opened at Rotherham, close to the new Mexborough extension of the Manchester, Sheffield, and Lincolnshire Railway. Messrs. Cooper and Co. are the proprietors, and the pit will be called the Roundwood colliery. A fine seam of coal has just been reached at a depth of nearly 200 yards.

Derbyshire Institute of Mining, Civil, and Mechanical Engineers.—At a meeting of this society, held at Chesterfield on Saturday last, Mr. Bromley read an excellent paper upon hydraulic engines as applied to drainage of mines. The paper will be further discussed at the next meeting. Mr. Robert Howe read a paper illustrating experiments made with the Guibal fan for ventilating collieries, which is in use at Staveley. Votes of thanks were given to the author of each paper. The council resolved not at present to amalgamate with the Barnsley Institute, and an allusion was made to the proposal to build a Stephenson memorial hall, at Chesterfield, for the use of the institute, and for other purposes. It was thought that it would cost from 6000*l.* to 10,000*l.*, and after some discussion the matter was allowed to stand over.

Proposed Covered Market at York.—It is proposed to erect a covered market, with a frontage to Parliament-street of 21 ft. It will be 194 ft. long and 60 ft. wide, with four entrances; one from High Tubbergate, one from Little Shambles, one from Great Shambles, and one from Parliament-street. The internal area will be about 2060 square yards, and the cost is estimated at about 18,500*l.*, not including parliamentary and other expenses.

Trades of South Yorkshire.—All the heavy trades of the district are in a very flourishing condition, and the turn-out is heavy, especially of Bessemer steel rails. There is at present no serious complication on the labour question, the Sheffield strikes having been compromised.

Eastern Bengal Railway.—This line has been damaged by the flooding of the Matabangah river. At Buggoola, Parodah, and Choca-dangah bridges have given away.

Steam Engines.—The value of the steam engines exported from the United Kingdom in August last was 263,347*l.*, as compared with 208,495*l.* in August, 1870, and 169,425*l.* in August, 1869. In the eight months ending the 31st of August this year the aggregate value of the same description of exports was 1,507,400*l.*, as compared with 1,409,654*l.* in the corresponding period of 1870, and 1,128,511*l.* in the corresponding period of 1869.

London Association of Foremen Engineers and Draughtsmen.—At the ordinary monthly meeting, held at the City Terminus Hotel on Saturday the 7th inst., Mr. J. Newton, C.E., president, in the chair. Mr. James Howard, M.P., was unanimously elected an honorary member of the institution, and Mr. Galloway read a paper, illustrated with diagrams, on "Improved Multitubular and Multiflue Boilers." The sitting was numerously attended, and the proceedings were on the whole of a most interesting nature.

STEAM ENGINE COEFFICIENTS.

To the Editor of Engineering.

Sir,—In your last issue, Mr. J. MacFarlane Gray merely reiterates, at greater length, the opinions expressed in his previous letter, without at all establishing the accuracy of the statements I undertook to prove erroneous.

Thus he begins again by assuming that the quantity of steam he finds in the high-pressure cylinder is the measure of the quantity expended in performing the work indicated by the diagrams of both cylinders. Now it is not necessarily so, nor in this case is it likely to be so. For under all ordinary conditions a correct measure of the steam can only be obtained from the actual terminal pressure, and when discrepancies like this occur between the measurements in the two cylinders, they should be dealt with in another way than Mr. Gray deals with them, as will presently be shown.

Now, if the theoretical expansion, under the law of constant products, due to an initial pressure of about 70 lb., and a terminal of 4.875, is not 14¼, I should like to know what it is. Mr. Gray then reproduces the diagrams to show that the quantity of steam has been correctly measured in the small cylinder, but he makes no effort to explain why that quantity cannot be found in the low-pressure cylinder. But Mr. Gray says the difference represents the loss. And all I can say is, that if all that difference is to be put to the account of loss, then all the generally accepted properties of steam under expansion are as fallacious as our notions regarding jacketted cylinders are absurd.

Again, when referring to certain circumstances that tend to show more steam at the end of the low-pressure cylinder, Mr. Gray thinks that I have not strengthened my argument in favour of measurement in the latter cylinder. Well, if I have not, I think it will puzzle Mr. Gray to weaken it, although he makes some attempt at doing so, by an absurd supposititious case of barrelled low-pressure cylinders, forgetting that such arguments are quite as available against measurements in the high-pressure cylinder.

Now, in the case of single-cylinder engines and compound engines, where the steam passes directly from one cylinder to the other, and when the latter are correctly indicated, it will very seldom be found that the quantity of steam measured at any part of the expansion is in excess of that found at the terminal point, but in the now common form of marine engines having two cylinders, and an intermediate receiver, such as those from which these diagrams were taken, the steam shown on the high-pressure card may be often in excess of that shown on a card taken simultaneously from the low-pressure cylinder, for the obvious reason that the diagrams do not measure the same steam, nor even necessarily the same weight of steam. Of course a mean obtained from a number of sets of diagrams, taken under the same conditions, would give an approximately correct measure of the steam expended each stroke, or, failing a sufficient number of diagrams, this may be obtained from one set by finding the terminal pressure due to that shown on the high-pressure diagrams, and by adding to, or subtracting from, the mean pressure in the high in the proportion that the actual terminal pressure shown in the low is above or below the terminal pressure due from the high-pressure cylinder. Thus in the diagrams under discussion the terminal pressure due to the steam shown in the high-pressure cylinder—by the formula for dry saturated steam—is 5.48, and the actual terminal in the low pressure is 4.875. The equivalent mean effective pressure in the high-pressure cylinder is 7.33, and, therefore, $\frac{7.33 \times 4.875}{5.48}$ gives 6.52 lb. as the actual equivalent pressure exerted during expansion in the high-pressure cylinder, and $\frac{6.52 + 8.337}{4.875}$ gives a coefficient of 3.15 instead of 3.32.

Next with reference to the fairness of stating the coefficient of perfection, there is evidently a mere quibble on the wording at issue between us; but I beg to direct attention to the calculation by which Mr. Gray gets the coefficient 3.154. This I refrained from noticing in my previous letter as the result of the blunder was not very material; but as Mr. Gray continues to use 3.154, and pompously challenges any question as to his accuracy even to the last decimal place, I now do so. He takes his theoretical coefficient, and from it obtains the coefficient due after the back pressure is deducted, by taking the effective pressure shown in the diagrams, i.e. the pressure of imperfection, instead of the theoretical pressure corresponding to his theoretical coefficient. Thus instead of $\frac{3.398 \times 16.167}{1.25 + 16.167} =$ 3.154 as he makes it; it should be $\frac{3.398 \times 19.563}{19.563 + 1.25} = 3.194$

This is certainly not accuracy to the last decimal place; but it is less the actual difference between the results than the jumble of perfection with imperfection, in connexion with Mr. Gray's claim to infallibility, that is here worthy of notice.

Mr. Gray next asks the reader to reflect on what we are seeking, and lays down as a law, that in order to obtain the quantity of steam, "we should measure the steam either unexpanded," or "expanded without loss of energy." Well, if we should do so, it is only because Mr. Gray ordains it, certainly not because the higher pressure is any better standard than the lower. Mr. Gray, no doubt, thinks he makes his arguments more convincing by his similes, they are certainly more homely than appropriate. I will modify the one bearing on this point, however, and ask if it is not as logical as before. He says: "to take the lower pressure as one measure, would be taking the area of cloth in a made coat, and without the 16.17 per cent. of scrap, as a measure of the quantity of cloth to be purchased for a coat." I say: "to take the lower pressure would be to take the largest coat that could possibly be made out of a given piece of cloth, as the standard of perfection, and just in the proportion that the scrap in any case exceeded 16.17 per cent., so would the finished coat be smaller than the standard coat. The standard of admitted perfection is quite as good as one beyond perfection.

But Mr. Gray also states that he takes as his measure the greatest quantity of steam *whatever* it is to be found, and if this happens to be at the terminal point of expansion, as it generally does, how does he get, I would ask, the measure of the steam expanded without loss of energy? or does it conveniently happen to have all its energy just when it shows highest there? No. Mr. Gray takes it then just as it is, not because he thinks it correct to do so, but because he cannot help himself. But again I ask, is this consistent with a claim of accuracy *to the last decimal place?*

In my previous letter I made the coefficient 2.95 on the assumption that all the steam shown in the small cylinder passed through the large cylinder, and inadvertently made the clearance a source of gain. This, however, did not alter the fact stated, that more than half the difference between the two methods was accounted for, and that they were brought within reasonably explicable discrepancies. I have shown, above, the nature and cause of those discrepancies, and have determined the coefficient of efficiency of these engines as 3.15. This is a long way in advance of 2.55, which Mr. Gray considers high, although I have been accustomed to consider the latter only a coefficient of mediocrity.

Finally, Mr. Gray claims the origination of this system of coefficients, and states that about 1864 the Messrs. Elder had not then adopted them. I cannot reconcile this statement with the fact that I happen to have by me copies of indicator diagrams, bearing date 1860, from several of the Pacific Steam Navigation Company's engines with coefficients worked out (all from actual terminal pressures), by the late Mr. Elder, and I think it is quite probable that Mr. Elder used these coefficients prior to 1860. At all events those who personally knew the late Mr. Elder will readily acknowledge that he was well able to originate a correct comparative test of efficiency without inspiration from Mr. J. MacFarlane Gray.

Yours respectfully,
Chas. Smith.

Hartlepool Iron Works, October 10, 1871.

P.S.—I had almost forgotten that I had another opponent in J. J. C., but as he commences his letter by virtually stating that expansion will not be the same in amount, if the given quantity of steam to be expanded is wire-drawn, instead of being freely admitted, I beg to be excused entering into any controversy based on such a hypothesis. I refer him, however, to the beginning of Mr. Gray's last letter, where he will find a correct definition of the term expansion. And if Mr. Gray cannot claim to have been the first to inform me what expansion is, I really think he will be justified in claiming to having first told J. J. C.

To the Editor of Engineering.

Sir,—My attention has just been called to Mr. Gray's letter upon the system of steam coefficients, in your paper of the 6th instant, in which he says:

"It was, on my recommendation, adopted by many Liverpool superintendent engineers, and about 1864 was presented by me to Mr. Alexander Elder, and the coefficients worked out by me for him on a set of cards he had brought with him to my house. The Messrs. Elder had not then adopted the system of coefficients, and I then pointed out to Mr. Alexander Elder of what value such a test would be to compare his brother's engines with those of other makers."

It would be interesting to know who were the consulting engineers in Liverpool who received Mr. Gray's assistance in this matter. As far as Messrs. Randolph, Elder, and Co. are concerned, I can bear testimony to the system having been in use by them long before 1860, and I now send you a sheet of lithographed diagrams of the steamer Bogota, worked out by them on that principle, and bearing the lithographed date of 22nd September, 1860, exactly four years previous to the time when Mr. Gray states that he made me a present of his valuable principle.

The diagrams may be interesting to you, and are at your service. You will notice that one figure shows the high-pressure cylinder of one engine worked direct to the condenser, owing to accident to large piston.

I am, Sir, your obedient Servant,
Alexander Elder.

2, Brunswick-street, Liverpool, October 11, 1871.

To the Editor of Engineering.

Sir,—In my last letter there was one point in the discussion on "Steam Engine Coefficients" in which I intended making a remark, but forgot to do so, viz., the deduction from the theoretical calculation of 1¼ lb. for back pressure. Now, even after reading Mr. Gray's last letter, I cannot see the fairness of this deduction. The standard with which the actual diagram must be compared is the greatest amount of work that could theoretically be obtained from the quantity of steam admitted to the high pressure cylinder expanded the same number of times as in the actual diagram. In other words, the actual diagram is to be compared with a perfect diagram for the same expansion. If the back pressure is deducted, the diagram will not be perfect, as in a perfect diagram the vacuum must be perfect, as well as other conditions. The greatest amount of work to be got out of a given volume of steam at a given pressure, expanded a given number of times, will be when there is a perfect vacuum at the back of the piston. It seems, therefore, totally unreasonable to deduct a back pressure equal to that in the actual diagram.

The back pressure must be reckoned among the other losses due to the inefficiency of the engine. This will then make the coefficient $\frac{3.32}{3.398}$ or .977. This seems very high, doubtless, but, in the theoretical coefficients, no allowance is made for the effects of steam jackets, which will sufficiently account for the high coefficient.

Yours truly,
London, October 11, 1871. J. J. C.

THE RIGHTS OF INVENTORS.

To the Editor of Engineering.

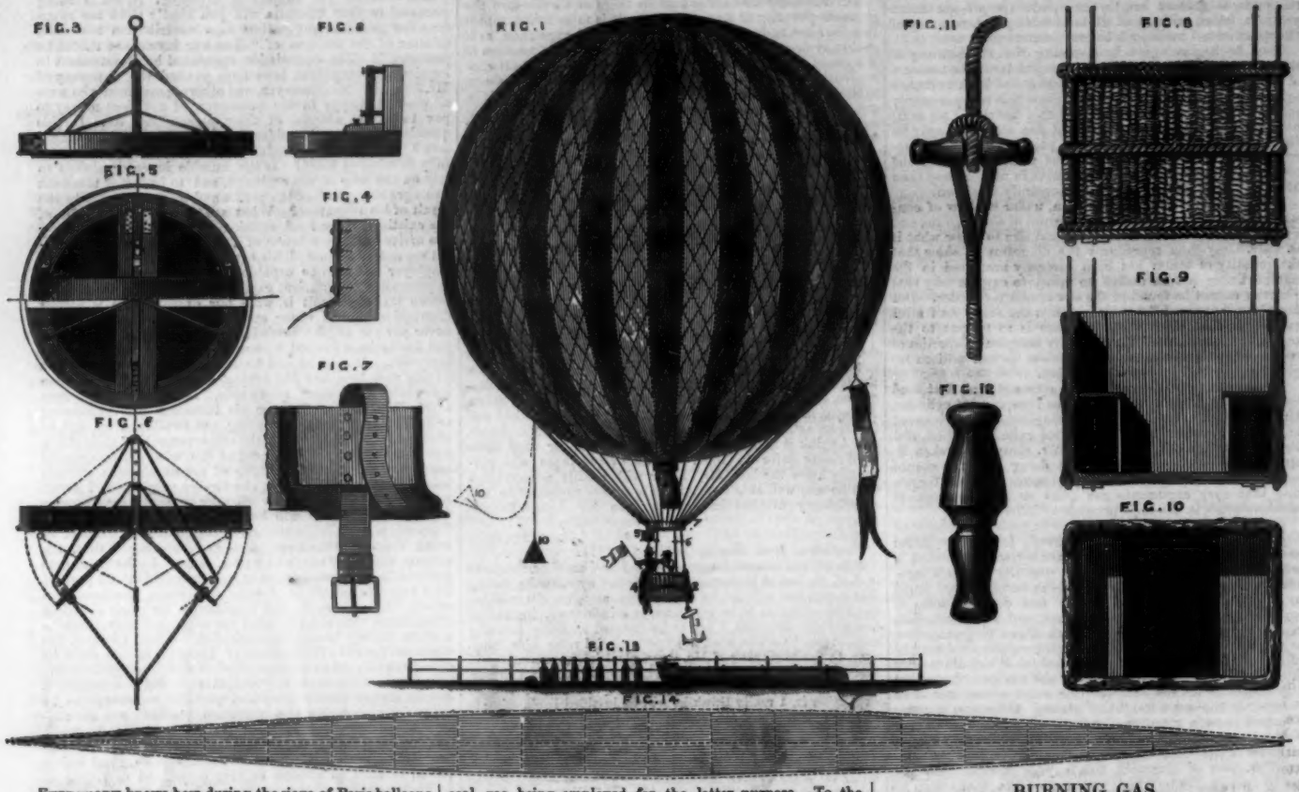
Sir,—Whilst the subject of inventors' rights is being discussed in your columns, will you kindly allow me space for a few practical suggestions as a contribution towards a solution of the problem of "How our inventions should be protected"? The commission appointed by Government to inquire into our patent laws have invited the testimony of Mr. Bessemer, Mr. Nasmyth, and others, gentlemen who were all probably happy in the possession of sufficient money to pay twice the amount of their patent fees, &c. Is this question never to be considered in its relation to the working man? Is a nation's productiveness to have no means of fully developing itself? Is the humble inventor always to rely on the help of the capitalist, and to be forced to accept a meagre share both of the profits and credit that may be the result of his invention? What are the every-day results of the existing system? A working man by constant thinking has arrived at the solution of some mechanical difficulty—his connexion is limited, his earnings small; no one but his employer seems to be capable of estimating its worth, and in possession of sufficient capital to patent it. He is to be shown it; the result is, with few exceptions, it is almost drowned with cold water, and the inventor is told it will never pay; it is like throwing money away in the street; and finally he is invited to accept a fractional share of the invention. It may be said he is not obliged to take it; but having once broached the subject he must, or his situation is rendered unpleasant afterwards. He is lucky to get even a fractional share, otherwise his invention may be rejected as altogether unfit for patenting, get swallowed up, and be afterwards puffed as one of the improvements of their rising concern. With such treatment as this, what encouragement has a man to invent? To those of my countrymen who are fearful of the competition of our foreign neighbours, I would say throw open some door whereby invention may breathe free as air, and you will be astounded with our national superiority. I will here make a suggestion at the risk of being thought ridiculous, but remembering "that ten censure wrong for one who writes amiss," I offer these suggestions for the consideration of your readers. Is it not possible for a board to be formed of some half dozen gentlemen removed from reproach, and remarkable for their scientific attainments, who shall sit after the manner of Royal Academicians, having inventions submitted to them (without the slightest clue as to the inventor)? These inventions could be submitted either in the shape of clear and intelligible drawings, or working models, provided they did not exceed a certain size to render them not portable, no charge to be made for undergoing this inspection, provided it is not considered deserving of protection, or if not original to be struck out from protection altogether. This court would be empowered to try all infringements, and also to grant letters patent to such inventions as they considered deserving of protection, and for *these* terms or grades, according to the nature and merit of the invention, say for 5 years, 10 years, and 15 years, for which terms a fee should be paid by the inventor of 2*l.*, 5*l.*, and 10*l.* respectively, according to the term allotted him; this charge is not too little for working men, and the increased number of patents would compensate for the reduction. There is a certain class of inventions which can be rapidly manufactured and realised. These, such as shoe blacking machines, knife-polishers, pills, and the like, cannot claim the same protection as the invention of a steam engine, and it is but fair that they be refused the grant of even five years, and be referred to the Registration Office, where they could obtain protection in a similar manner, but for a shorter term, say, one, two, and three years, according to the nature of the invention, by payment of 10*s.*, 1*l.*, and 30*s.* respectively, affording no protection whatever to inventions not original. These charges are as much as a workman could afford to risk in speculation, and I would even go further if an inventor should be fortunate enough to obtain a grant of 15 years, it should be optional to him to pay the sum of 10*l.* down, or to pay the first instalment of *N.* down, and the rest afterwards, with a percentage of interest added, these two remaining instalments, with the interest to be paid at the beginning of each new term. I do not see that the inventions of literature can be mixed up with mechanical contrivances. But at Stationers' Hall proper judges could be appointed to deal with them as with other inventions. These crude ideas I submit to your readers, convinced of the inutility of complaint without remedy, and wishful to see the subject handled by some clear-headed person abler than

Your humble Servant,
A Working Man in the North.

Bradford, October 9, 1871.

Mr. Thomas Pilgrim.—We have to record the death of Mr. Thomas Pilgrim, whose name has been for many years past associated with that of Mr. F. P. Smith, in connexion with the development of screw propulsion. Mr. Pilgrim was born in the year 1800, and died, on the 6th instant, at Plumstead, Kent. In 1826 a small steam vessel, of 10 tons burthen, was built and fitted with a Smith screw, and, engineered by Mr. Pilgrim, put to sea in 1837, visiting Dover, Folkestone, &c., in heavy weather, thus demonstrating that the screw would act in rough as well as in smooth water. In the following year the Archimedes, a vessel of 237 tons burthen and 80 horse power, was built by Messrs. Rennie. This ship is celebrated in the history of steam navigation as being the first vessel ever sent to sea propelled by a screw, and to her Mr. Pilgrim was appointed engineer-in-chief. Mr. Pilgrim was also the inventor of an apparatus for superheating steam, which consisted of a series of arched pipes placed in the boiler furnace, and through which the steam was conducted on its way to the cylinders. The apparatus was applied, about the year 1860, to H.M. steam tug Bustler and several vessels in the mercantile marine, but does not appear to have been used since that time.

THE PARIS BALLOON POST.



Everybody knows how during the siege of Paris balloons did good service in maintaining the communication between the encompassed city and the outside world; and even now when the time of siege has long past and the disastrous war in which it formed one of the leading events has, happily, been brought to an end, it may be of interest if we give some detailed particulars of the construction and equipments of the balloons which were so successfully used by the Parisians for postal service.

Between the 20th of September, 1870, and the 28th of January of the present year, no less than fifty-four balloons left Paris charged with letters and despatches; the letters thus transported being about 2,500,000 in number and weighing altogether about 10 tons. Besides this freight about a hundred persons were conveyed from Paris by these postal balloons, these being of course mainly employés of the post office or of the Government, there being included amongst the latter M. Gambetta, who took his departure on the 7th of October, 1870, conducted by M. Louis Godard, and M. de Kératry, who left Paris on the 14th of the same month accompanied by M. Godard, senior. Of the fifty-four balloons, twenty-nine were started from the station of the Paris and Orleans Railway; sixteen from the station of the Northern Railway; three from the station of the Eastern Railway; three from the Place St. Pierre, at Montmartre; two from the garden of the Tuileries; two from the Boulevard d'Italie; one from Vaugirard; and one from La Villette. The fifty-four ballons we have mentioned were those employed in the postal service; but besides these there were about ten others employed for scientific or miscellaneous purposes. Of the fifty-four postal balloons, about thirty-eight were constructed by MM. Godard frères, and about sixteen by MM. Dartois and Yon. Each *ballon monté*—or balloon with an aëronaut—carried a cage containing from 4 to 30 carrier pigeons according to the number available at the time the balloon was despatched, these pigeons being subsequently employed to convey return messages to Paris. These return messages were, as most of our readers are aware, minute reductions of the letters to be transported prepared on extremely thin paper by the aid of photography, these microscopic reductions being enlarged and copied off on their arrival in Paris in a manner which has already been described in these pages (vide page 86 of our last volume).

The form and equipment of the balloons constructed during the siege by MM. Godard frères, are shown by the annexed engravings, for the originals of which, as well as for the particulars contained in the present notice, we are indebted to our contemporary the *Portefeuille économique des Machines, de l'outillage et du Matériel*. The principal dimensions of these balloons were as follows:

Diameter	51 ft. 8 in.
Superficies	8390 square feet
Contents	72,240 cubic feet

The balloons were of a spherical form and were made of highly glazed calico varnished, each being composed of forty gores of the shape shown in Fig. 14. The gores were cut to shape with perfect regularity, and were strongly sewn together with a coarse double waxed thread. This being done, the exterior received two coats of varnish, and then as soon as the balloon was dry, it was ready for inflation; ordinary coal gas being employed for the latter purpose. To the lower aperture of the balloon was fitted a wooden ring 2 ft. 7½ in. in diameter, which was united to the sheet-iron pipe 5 ft. long which placed the balloon in communication with the gas pipes. Above, the balloon was fitted with a valve consisting of a ring of oak 2 ft. 7½ in. in diameter, provided with a couple of semicircular valves kept closed by india-rubber bands, and arranged so that they could be opened by means of a cord which passed down to the car through the interior of the balloon. (See Figs. 2, 3, 4, 5, 6, and 7.)

The balloon was enveloped and connected to the suspension ring by strong tarred hempen cords as shown in Fig. 1, while the suspension ring, which was 3 ft. 3½ in. in diameter by 3.2 in. high and 2 in. thick, was provided with *gabillots* (see Figs. 11 and 12) to which were attached the eight cords of the car. The latter—shown in Figs. 8, 9, 10—was made of wicker work and Indian reeds, and was 3 ft. 7½ in. deep by 4 ft. 7 in. long and 3 ft. 7½ in. broad, while the distance between it and the suspension ring was 6 ft. 7 in.

The total height of each balloon was 66 ft., and its weight, 913 lb., was distributed as follows:

	lb.
Balloon	466.4
Netting	123.2
Suspension ring	24.2
Anchor	55.0
Car	110.0
Guide rope	99.0
Anchor rope	35.2
Total	913.0

The aëronauts—who were trained in the school of aërostation established by MM. Godard during the siege—carried with them in the car a barometer, a thermometer, a compass, a safety lamp, some cards and twenty streamers of paper, each about 30 metres long, which served, during the progress of the balloons, the purpose of enabling an estimate to be formed of the direction and force of the wind blowing below. Besides these articles there were also carried a flag bearing the name of the balloon; a triangle of paper which was hung about 6 ft. 6 in. below the balloon, and which served to show whether the latter was ascending or descending; a parachute attached to the equator of the balloon and which served to check the descent; 660 to 1100 lb. of ballast, a wrought-iron anchor, four mooring ropes, and a guide rope about 650 ft. in length. This latter rope, which was made half of hemp and half of rushes, was thrown out during the descent in order that it might be seized by the people below and the progress of the balloon thus checked. During the siege MM. Godard frères were capable of turning out such a balloon as that we have described, complete with its equipment, in about two days.

The Rigi Railway.—The Rigi Railway, which is only 5.14 kil. in length, has conveyed, from the 23rd May to the 31st August, 43,260 passengers and 20,162 cwt. of luggage; its receipts were 181,000 francs. The capital for the construction of the line being 2,250,000 francs, the product was to the end of August about 15 per cent.

BURNING GAS.

To the Editor of Engineering.

Sir,—With reference to the article in your last issue on "Burning Coal Gas," I beg to say that the inaccuracy of "Farmer's theorem" was demonstrated by me in the columns of your contemporary the *Journal of Gas Lighting*, long before the report of the referees on the subject of gas burners saw the light (see pages 158 and 440, vol. xix.). That this demonstration was accepted by the gas world is sufficiently evident from the address of the late President of the British Association of Gas Managers, delivered at their recent meeting in Dublin, in which reference was made to the discussion which followed the introduction of the new theorem. At the same time, and in a subsequent communication (page 352, vol. xx.), I endeavoured—not, I think, unsuccessfully—to show that the discrepancy in illuminating power observable at different rates of consumption with the same burner, is attributable solely to the varying conditions affecting such consumption, which it is impossible wholly to meet with in one and the same burner; and further, that the best obtainable results being in perfect conformity with the law of simple proportion, the limits of operation of such law afford an easy and satisfactory method of determining the limits of economical luminous combustion applicable to any burner.

It is apparent, therefore, that, whether these views be sound or not, so far as they are embodied in this report, they are not now put forward for the first time.

I remain, Sir, yours truly,

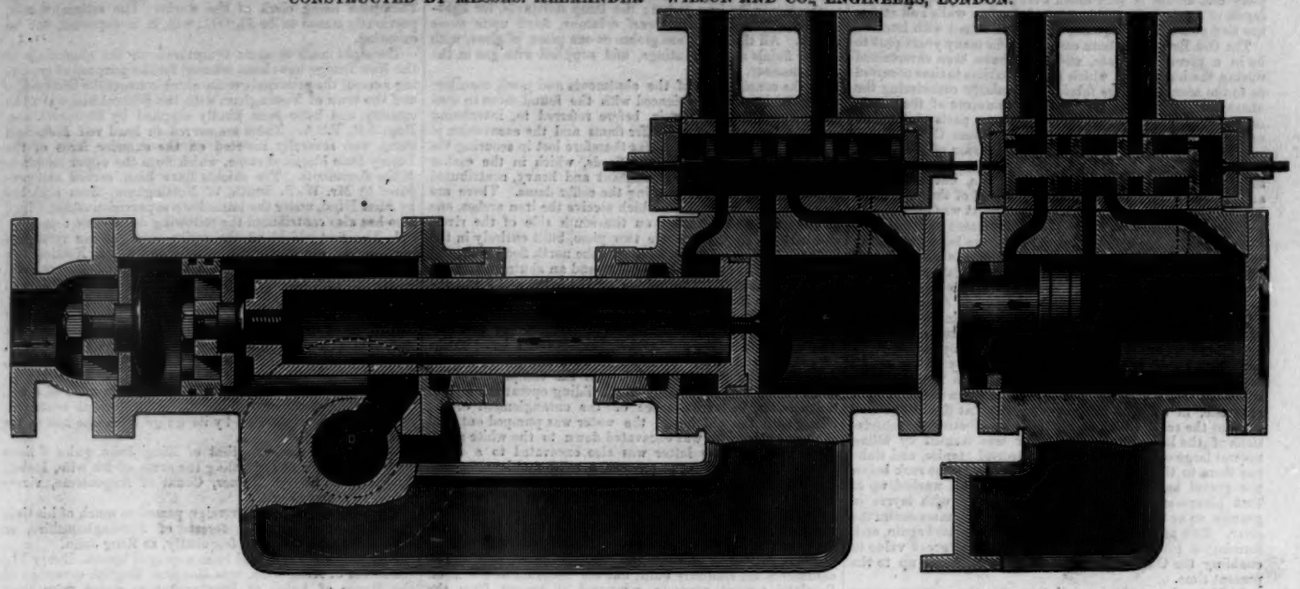
Charles Hunt.

Nine Elms, October 11, 1871.

The Sewage of Cambridge.—For some considerable time the Cambridge Improvement Commissioners, of which body the masters of colleges are members, have had under their consideration the importance of taking steps for the diversion of the sewage from the river Cam. The stream has become polluted with the sewage, and although the university have spent some thousands of pounds in its purification, the evil, owing to the sewage, still exists. The commissioners have been urged to action, the public health has been in danger; and yet, from a want of unity as to the scheme that shall be adopted—whether by irrigation or deodorising—delay after delay has occurred. Now that the university are up the question is again introduced, and Mr. Bailey Denton, who has been consulted, endorses the opinion given by the town surveyor (Mr. Stephenson) that the scheme of irrigation will be the best. At a committee meeting held on Monday the subject was fully gone into, when, notwithstanding that the evil was admitted, no definite plan could be agreed upon; and at a meeting of the Board on the following morning no report was presented. The Board, before expending a sum of something like 60,000*l.*, express a desire to have placed before them some sound foundation for adopting the scheme of irrigation; and, consequently, it was determined to adjourn the meeting until the 31st inst. The desired evidence as to the efficiency of irrigation will no doubt easily be afforded, and it is to be hoped that the Commissioners will then act promptly. There has been far too much delay already.

BAUMANN'S STEAM DONKEY PUMP FOR TRACTION ENGINES.

CONSTRUCTED BY MESSRS. ALEXANDER WILSON AND CO., ENGINEERS, LONDON.

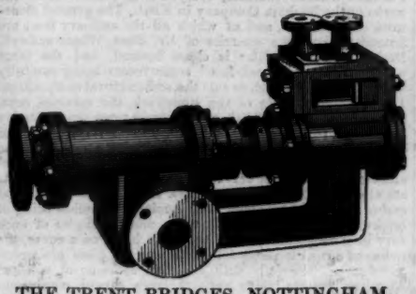


In our impression of October 21st, 1870, we illustrated and described Mr. Baumann's patent valve motion for a single acting donkey pump having two moving parts only. Having had some inquiries for steam pumps to fill the tanks of road steamers from ponds or streams, which they may be passing, and economy of space being of course of the highest importance, Mr. Baumann has designed a special pump for the purpose, and we are glad to hear that the invention has been applied with success to two of Thomson's road steamers.

The engravings, which we herewith give of the new pump, are, when taken in connexion with our former description of Mr. Baumann's plans, sufficiently clear to be understood without further explanation; we only wish to draw the attention of our readers to some details in the construction of this exceedingly simple engine. It will be remembered that in Mr. Baumann's pump a differential piston valve is used by means of which the steam distribution is effected. In the engine we illustrate, it was found desirable to have a piston valve of a diameter of 2 in., and the difference of the two areas, back and front, ought to be about the third part of a square inch. To make a differential piston valve of this kind, the valve cylinder was cast separately without any passages and bored out; a plain cylindrical piece of cast iron, the future valve, was fitted into it, and then a hole was drilled, parallel to the axis of the cylinder, and so situated, that the drill worked half in the iron of the valve cylinder and half in the iron of the future piston valve; a pin was fitted into this hole and fixed to the valve cylinder. The front area of the future piston valve was thereby reduced to the required extent, it was now taken out of its cylinder and turned down to the shape shown in the engraving. The steam passages are milled into the valve cylinder as shown in the drawings.

For the purpose of not only filling the tanks of the road steamer but also for feeding the boiler, a steam pump, similar in appearance to the one we illustrate, has been designed by Mr. Baumann; the piston is of the same shape, but plain, so that at one end there is a single acting pump of the whole diameter of the water cylinder, used for filling the tank; and at the other end another single acting pump of an effective area equal to that of the plain piston minus the area of the ram used for feeding the boiler. The diameter of the pump cylinder is smaller than the diameter of the steam cylinder, so that the effective area of the steam piston is larger than that of the feed pump.

The steam pump we illustrate throws 1600 gallons per hour, it measures 30 in. in length, 12 in width and 18 in height; it weighs 1 cwt. 2 qrs. and has been manufactured from Mr. Baumann's design at the Vauxhall Iron Works, London, by Messrs. Alexander Wilson and Company.



THE TRENT BRIDGES, NOTTINGHAM.

We publish this week a two-page engraving, together with a perspective view, on page 333, showing the new bridge now being constructed over the River Trent at Nottingham, from the designs of Mr. M. O. Tarbotton. This new structure is intended to replace the Old Trent Bridge, which has long possessed great interest for antiquarians from its numerous historical associations. The new bridge will be a very handsome structure, the general proportions being excellent, and the design of the abutments particularly effective. Mr. Tarbotton—to whom we are indebted for the use of the contract drawings from which our engravings have been prepared — has lately prepared and published a highly interesting account of the Old Trent Bridge and description of the new structure; and this account is so complete that we have considered that we could not do better than reprint it here to accompany our engravings. It is as follows:

The Old Trent Bridge is full of historic interest. The site of it has for ages past been the crossing place of the river Trent, connecting the South of England with the North, and with Scotland. Originally perhaps a ferry, later a ford, and ultimately a "brigg"; enabled armies, kings, and people to cross the mid-barrier of England; and, while at one period the bridge at this place was the scene of royal strife and local anarchy, now it stands in the centre of a peaceful and industrious island, an interesting relic of the past, and unfit for the purposes of its Saxon founders only by the disturbing elements of nature, and the imperious demands of modern civilisation.

The early history of this ancient structure is lost in the clouds of antiquity, but, from all the information that can be culled from historical documents and works, we can have no doubt but that, prior to the erection of the first bridge, a ferry or ford existed across the river on the site of the future bridge, and that landing stages were used on both sides of the river: this is confirmed by the finding of traces of one of the early oak landing stages in making the excavations for the south abutment of the present New Bridge. From the Saxon chronicles we are informed that the first bridge was built by Edward the Elder, in the early part of the tenth century, about 140 years before the Norman Conquest. This bridge was called the "Heathbethe Brigg," or High Bath Bridge, and is said to have consisted of stone piers and timber beams or framing, which was the character of the bridges of that date. The second bridge was built of stone, and portions of this bridge now form part of the existing old structure. From the form, character, and construction of the old arches there can be no difficulty in ascribing to them the date of the transitional period, between the Norman and Early English, or the middle of the twelfth century. This also corresponds with the time at which Henry II. rebuilt the wall round the town, and it is not improbable that the first arched bridge was also built by him. The two southernmost arches are the only perfect ones of the above date, and are very beautiful. It is not intended to take down the extreme southern arch, but to retain it as an example of Early construction; and, inasmuch as the retention of it will not interfere with the New Bridge, or any other property or work, it is most desirable to keep some relic of this interesting building. The reparation of this bridge, it is recorded, was undertaken by the Brethren of the Hospital of St. John of Jerusalem, but as time progressed, and as the structure suffered much from floods and from wars, especially from the civil wars of the Caroline period, its sustentation became otherwise provided for, and ultimately it assumed the position of a County Bridge, the reparation being intrusted to the Corporation of Nottingham, to whom, for the purpose, divers grants of money and lands were made by the Crown and private benefactors. In 1683 a destructive flood arose throughout the whole of the Trent Valley, occasioned partly by the breaking up of an extraordinary frost, accompanied by much snow, and thereby a considerable part of the bridge was swept away and destroyed. The Corporation of Nottingham at this date (1683) appointed a committee for rebuilding the bridges or arches so destroyed, and it is clear that the first five, and perhaps two other, of the arches at the northern end were rebuilt at this time, the remaining arches having been restored and repaired at the time of and subsequently to the civil wars.

Repairs and partial rebuilding of various kinds have been done since the latter period by the corporation, and a perusal of the hall books reveals many quaint memoranda as to the mode of performing the works of sustentation, and providing the money for the same.

The bridge as it now stands contains 15 arches in that portion of it which may be termed the bridge proper, of these arches the first 11 appear to have had each a span originally of 25 ft. at the widest points, making an extreme waterway of 275 ft.; the remaining 4 arches, varying from 18 ft. to 22 ft. span, were evidently either for flood water or for sustaining the roadway: the waterway in the aggregate afforded by the 15 arches, measured at the widest parts of the openings, amounts to about 347 ft., but measuring between the platforms of the starlings, the waterway does not exceed 270 ft. The sum of the widths of the several piers amounts to about 191 ft., this gives a total length for the bridge proper of about 538 ft. Immediately south hereof a mass of masonry occurs, supporting the roadway, and then follow the two small and most ancient arches previously described, probably intended, when they were built, to span some old arm of the river, being each about 17 ft. in width. The extreme length of the structure from the north abutment to the London road is about 668 ft.

The bridge has been widened at different times; the original width did not probably exceed 12 ft., but to increase the convenience of the roadway the pointed arches have had collateral arches of segmental and elliptic form built against them of comparatively inferior and inartistic workmanship. The present width of the roadway between the parapets is from 18 ft. 6 in. to 21 ft. 6 in., and there are no footpaths.

The foundations of the Old Bridge are formed of oak piles, which are driven into the gravel-bed of the river. The depth to which they reach has not been ascertained, but it is quite certain that the safety of the structure has been frequently endangered by the scouring action of the river around them. The masonry does not extend much below mean summer level, and during a dry summer the skeleton platform of the piers is greatly exposed. The materials of the bridge are bricks and stone—the former have been of a very durable and superior quality. The stone of the older parts of the work has been obtained from the local keuper beds of the new red sandstone, and that of the modern parts from the millstone grit of Derbyshire. In this bridge is proved the complete durability of the local beds of sandstone,

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Suez Canal.—The negotiations which have for some time been pending between the Lords of the Admiralty and Sir Daniel A. Lange, on the part of the Suez Canal Company, for the purchase of land situated at the Port Said entrance of the canal, have been finally concluded.

Railway Station at Gloucester.—The inhabitants of Gloucester are agitating, and with good reason, for the erection of a suitable railway station, to replace the disgraceful structure which at present serves that purpose. In reply to a petition addressed to the Midland Railway Company, the chairman, Mr. Price, expresses his willingness and that of his co-directors to vote a sum of money for the desired purpose as soon as due terms have been made with the Great Western Company. It is to be hoped that the latter company will not act obstructively in the matter.

which now are very little used, and also the suitability of Derbyshire grit for similar purposes. The masonry of the piers and arches is very much shaken in various places, the result of floods and subsidence, and the face walls and arches are tied and bonded together to a great extent with iron.

The Old Bridge has been considered for many years past to be in a precarious state, and fears have been entertained during the high floods which have from time to time occurred as to the security of the fabric, particularly considering the character of the foundations and the nature of the strata on which they rested, and especially as no parts of the piers enter the solid rock. In 1853 Sir William Cubitt, C.E., was consulted on the subject of the condition of the bridge, and he recommended the erection of a new one, for which some preliminary sketches were then made, but no further active steps were taken until the latter end of the year 1867. The bridge proposed by Sir William Cubitt was intended to be placed a little lower down than the present new one, and thus the old "Town Arms" would not have been disturbed; but this arrangement, in consequence of the alteration of the levels, would have seriously injured the latter building, besides involving a complete detour from the London road to cross the bridge.

The bridge committee, however, in the interim above-named, impressed with the conviction that some measures were necessary to sustain the Old Bridge beyond the ordinary repairs thereto which were constantly being made, constructed, in 1869, a sunk weir across the river, a little below the Old Bridge, and, in fact, on the site of the present new one, in order to hold up the water at the bridge and prevent the scour which was so seriously affecting the foundations of the large piers. This weir was formed by filling several large old barges with Mountsorrel granite, and sinking them to the bed of the river, or rather to the rock below the gravel bed—the gravel having been all washed up at that place—and then covering the whole with layers of granite, so as to form a continuously compact mass across the river. This promoted the deposition of the gravel again, and, forming a protective weir, no doubt was of great value in enabling the Old Bridge to continue in existence up to the present time.

In November, 1867, immediately after the commencement of the first mayoralty of John Barber, Esq., instructions were given to Mr. M. O. Tarbotton, C.E., to prepare fresh plans and estimates for the New Bridge, and in April, 1868, these plans were submitted to the Town Council, at a special meeting, and unanimously agreed to. A report also accompanied the plans, detailing the entire proposal, describing the levels and state of the river, the condition of the Old Bridge, the insufficiency of the foundations, the influence on the structure of the waterway and the floods, and discussing fully the new project, giving all particulars as to the intended mode of construction, and the estimated expenditure, which was put down at 31,000*l.*

On the acceptance of the designs for the New Bridge by the Council, arrangements were immediately made for the commencement of the works, and in the early part of September, 1868, the first sod was turned on the south side of the river. No architectural deviation has been made in the building of the bridge from the original designs, and the works are now nearly completed. The total length of the bridge is about 700 ft. from the north abutment to the end of the south approach on the London road, the clear width between the parapets is 40 ft., and from face to face of the abutments 48 ft. 8 in., being practically the same width as Southwark and Waterloo Bridges, London. The width of the approaches increases very rapidly from the bridge proper, in order to facilitate the junctions of the several roads on the north and south sides of the river. The height of the roadway above the summer water level of the Trent is 27 ft., and there are two footpaths each 7 ft. wide, with a carriage-way 26 ft. wide, capable of accommodating easily three lines of carriages.

The New Bridge consists of three main arches or spans, each 100 ft. wide in the clear, one north flood and haling path arch, 10 ft. span, and three south flood arches, 18 ft., 15 ft., and 12 ft. wide respectively. The surface of the bridge is quite level, and the north approach has a gradient of 1 in 47 and the south 1 in 34.

The material of the large main arches is cast iron, and each arch has eight ribs or girders, which weigh about 200 tons.* These ribs sustain transverse wrought-iron girders, which are bolted thereto, and which in turn carry the roadway sheet; the latter is formed of wrought-iron curved plates and Mallett's buckled plates, all which are rivetted together and to T and angle iron bearers and straps. Every arch has strong bracing frames to connect the several ribs together, and all the joints of the ironwork are planed true and connected with iron pins or bolts, which were previously turned smooth in a lathe and fitted into holes correspondingly drilled through the ironwork. The face ribs are of an ornamental character, and are moulded on the lower edges, and on the upper lines of the arches. The spandrils are deeply recessed and moulded, and contain medallions of cast iron fitted within geometric cuspings which are enclosed in moulded circles or tracery. The designs for the enrichments vary in each compartment both in size and detail—these were all modelled and prepared by Messrs. Farmer and Brindley, of London, the sculptors, but cast at Derby. Over the arches and spandrils, an ornamental moulded cornice, of cast iron, runs from pier to pier, and the lower part embraces a rich filling of conventional foliage, composed of leaves and lilies, also of cast iron. The whole is surmounted by the parapet, which is of geometric and continuous design formed of cast-iron open-work, with paterae or flowers at the intersections of the curved lines. The top member is moulded, and the lamp standards, for lighting the bridge, are designed as permanent features to correspond with the parapets, and form an integral part thereof. The parapets of the north and south approaches, over the stone arches, are of similar design and construction to those over the iron arches; the lamp standards, for lighting the approaches, are dwarf columns, fixed upon stone pillars. All the lamps are globes in one piece of glass, with copper finials and mountings, and supplied with gas in the usual manner.

In the construction of the abutments and piers, considerable difficulty was experienced with the foundations in consequence of the sunk weir, before referred to, interfering with the formation of the coffer dams and the excavation of the river bed. Much time was therefore lost in securing the foundations, especially as the floods, which in the earlier part of the work were very constant and heavy, contributed also to the difficulties attending the coffer dams. There are two large main abutments which receive the iron arches, one on the north and the other on the south side of the river, and between these there are two piers, built entirely in the water. Another abutment receives the north flood arch, and on the opposite side are two piers and an abutment for the south flood arches. The residue of the north and south approaches are sustained by curved stone battering retaining walls. All the foundations in the river were built by the aid of coffer dams, and, in the making of these, divers were employed to destroy the old boats and remove the large blocks of granite and other materials, so that the piling for the dams could be proceeded with. On the completion of the dams (which in the course of the building operations several times burst, in consequence of the entanglement of the piling with the old boats) the water was pumped out, and the bed of the river was excavated down to the white sandstone rock, and the latter was also excavated to a depth varying from 2 to 5 ft., to procure a solid and level bottom for the masonry. The foundations of the piers were constructed of large blocks of Derbyshire ashlar, cramped together with iron, and upon these the masonry of the piers was built up. The faces are formed of blocks of stone, filled up behind with rubble masonry, the whole being laid in ground Barrow Lias lime and washed Trent sand. The abutments are similarly built, but the foundations rest upon Portland cement concrete, composed of cement from the works of the Burham Company in Kent. The general stonework of the bridge, and of which all the ordinary faces are formed, is from the quarries of Mr. Sims, Whatstandwell, Derbyshire; the ashlar is clean boasted, and the front walling blocks are rock-faced, some fronts being carefully dressed with the chisel, to suit the architectural composition. The ornamental parts of the stonework, the cornices, caps, pedestals, recesses, and other superior features are of Darley Dale stone, from the quarries of Sir Joseph Whitworth, and of red Mansfield and Mansfield Woodhouse stone, from the quarries of Mr. R. Lindley. All this stonework is cleansed and either moulded or carved. The south approach parapets are also of Darley Dale stone, rock faced. The south flood arches have moulded stone arch quoins, the arches being of brickwork, each arch is on the skew, and the angles of each vary in consequence of the approach being on a curve, the radius of which is about 300 ft. The river piers are terminated at all the ends with clustered columns of polished Aberdeen granite, these support large carved caps upon which are placed blocks of red Mansfield stone, the latter forming on the inside next the footpath seat recesses for the accommodation of foot passengers crossing the bridge. Cornices over these of richly carved Darley Dale stone complete the upper finish of the piers; the recess blocks on the external faces are deeply sunk in the solid stone, and have on all the fronts areaded ornamentations, with polished serpentine granite shafts from Cornwall.

The carriage roadway of the bridge is formed, firstly, of a layer of bituminous concrete, to protect the iron plates from oxidation; secondly, of a foundation of Portland cement concrete, several inches in thickness; and thirdly, of a layer of Val-de-Travers asphalte, from the quarries in Switzerland. This latter material has been laid by the Val-de-Travers Company, London, who have lately executed much work of the kind for the Corporation of London in various streets of the City. The channels and curbs are of cast iron, and the footpaths are laid with sawn Spinkwell landings from Yorkshire.

The contractors for the works of the New Bridge were as follows:—Messrs. Benton and Woodiwiss, of Derby, for the general building and masonry work; Messrs. Andrew Handyside and Co., of Derby and London, for the ironwork; Messrs. Mawer and Ingle, of Leeds, for the general carving; and Mrs. Marshall, of Nottingham, for the painting and decoration.

In connexion with the above-described works, extensive alterations and improvements have been effected on the banks of the river to increase the waterway. The old "Town Arms" Inn has been taken down, and a large new hotel, of brick and stone, erected in its place. The house and shop of the adjoining corn mill have been taken down and rebuilt. These new buildings have been necessitated in consequence of the north approach having been raised opposite the old houses about 8 ft. The buildings correspond with the design of the bridge, and have been erected by Mr. Shepperson, of Nottingham, contractor. The "Union" Inn, on the east side of the London road, has also been taken down and rebuilt on the old foundations by the last-mentioned contractor, but in a perfectly plain style. At the south end of the bridge the county magistrates have erected a new police station and lodge, and removed the old house. The new structure has an ornamental character, and is built of Darley Dale stone to correspond with the bridge, being on the approach thereof. Messrs. Bell and Son, of Nottingham, were the contractors. By an arrangement with J. C. Musters, Esq. (through Mr. Huskinson), great improvements have been carried out on the property of the Corporation and Mr. Musters at the south-east end of the bridge, opposite the police station, in order to effect a better communication between the south approach and the Newark-road. The whole of the works of the New Bridge, and of the adjoining buildings and improvements, have been executed from the designs and under the direct superintendence of Mr. M. O. Tarbotton, F.G.S., M. Inst. C.E., Nottingham—Mr. George Thompson being clerk of the works. The estimated cost, previously stated to be 31,000*l.*, will, it is expected, not be exceeded.

The eight coats of arms sculptured on the abutments of the New Bridge have been selected for the purpose of typifying some of the principal events which connect the Old Bridge and the town of Nottingham with the general history of the country, and have been kindly supplied by Thomas Close, Esq., J.P., F.S.A. These are carved in hard red Mansfield stone, and severally inserted on the exterior faces of the Darley Dale blocks of stone, which form the upper members of the abutments. The shields have been carved and prepared by Mr. W. P. Smith, of Nottingham, from sketches by Miss Hind, under the immediate supervision of Mr. Close, who has also contributed the following description:

1. The first shield of the series, commencing from the north-west, commemorates the erection of Nottingham Castle early in the reign of William the Conqueror, and which was immediately committed by him to the custody of his reputed natural son, William Peverel.

Its bearings exhibit the arms of William I., King of England and Duke of Normandy, gules, two lions passant gardant, or; and of his wife, Maud, daughter of Baldwin, fifth Count of Flanders, viz.—gyronny of 8, or, and azure, an inescutcheon, gules.

These arms are conventional, for hereditary coats of arms, as now understood, were unknown in the eleventh century.

The shield is suspended by its guige from the hilt of the Conqueror's sword.

2. The next shield is that of King John, gules, 3 lions passant gardant, or; impaling the arms of his wife, Isabel, daughter and heir of Aymer, Count of Angoulême, viz.—lozengy or, and gules.

Probably no English sovereign passed so much of his time in Nottingham and the forests of Nottinghamshire, or crossed the Old Bridge so frequently, as King John.

This shield is suspended from a sprig of broom. Henry II., the father of King John, was the first English sovereign of the House of Anjou or Plantagenet, so styled from their badge or device, the broom; in Latin, *planta genista*.

3. The third shield is that of King Edward III., as borne by him before the title and arms of France were assumed, viz.—gules, 3 lions passant gardant, or; impaling the arms of his wife, Philippa, third daughter and co-heir of William I., Count of Hainault and Holland, viz.—quarterly, 1st and 4th, or, a lion rampant, sable, Hainault; 2nd and 3rd, or; a lion rampant, gules, Holland.

This inescutcheon typifies the seizure of Queen Isabella and her paramour, Roger Mortimer, Earl of March, in Nottingham Castle, through Mortimer's hole.

The shield hangs from a *fleur-de-lis*, the emblem of Edward III.'s descent from the Kings of France, and his subsequent assumption of their title.

4. The fourth shield shows the arms of David II., King of Scotland, viz.—or, a lion rampant, within a double tressure, flory, counterflory, gules, impaling gules, 3 lions passant gardant, or; being the arms of his wife, Joan, the eldest daughter of Edward II., King of England.

This shield records the imprisonment of King David in Nottingham Castle, after the battle of Nevill's Cross, near Durham. It hangs from the Scotch thistle.

5. The fifth shield, on the eastern side of the bridge, presents the arms of King Richard II., viz.—quarterly, old France and England, impaling the arms of his first wife, the good Queen Anne of Bohemia, quarterly 1st and 4th, or; a spread-eagle, sable, Germany, 2nd and 3rd, gules, a lion rampant, double-tailed, argent, Luxembourg.

These are the arms which, in the times of Thoroton, existed in a window of the south aisle of St. Mary's Church, Nottingham.

King Richard II. resided much in Nottingham Castle. In his reign the beautiful nave and transepts of St. Mary's Church were built, probably under the plans and directions of William of Wykeham. The two mutilated crowned heads, terminating a curious hood moulding over a doorway in the north aisle, are those of King Richard and Queen Anne.

This shield therefore commemorates the building of the nave and transepts of St. Mary's Church. It is upheld by an angel, and King Richard's arms on the north front of Westminster Hall are so supported. The support harmonises with the construction and the religious objects of St. Mary's Church.

6. The next is the inescutcheon of King Richard III. and of his wife, Anne Nevill, viz.—modern France and England, quarterly, impaling quarterly, Nevill, Earl of Warwick and Salisbury, Montacute, Beauchamp, and Clare.

This shield commemorates Bosworth Field—for King Richard III., who resided a good deal at the Castle, marched thence over the Old Bridge to that celebrated battle where he lost both kingdom and life.

The shield is suspended from the ragged staff of Warwick, the family badge of King Richard's wife.

7. The armorial bearings of King Charles I., France and England, quarterly, surrounded by the Garter, and marshalled with the arms of his wife, Henrietta Maria, daughter of Henry IV., King of France and Navarre.

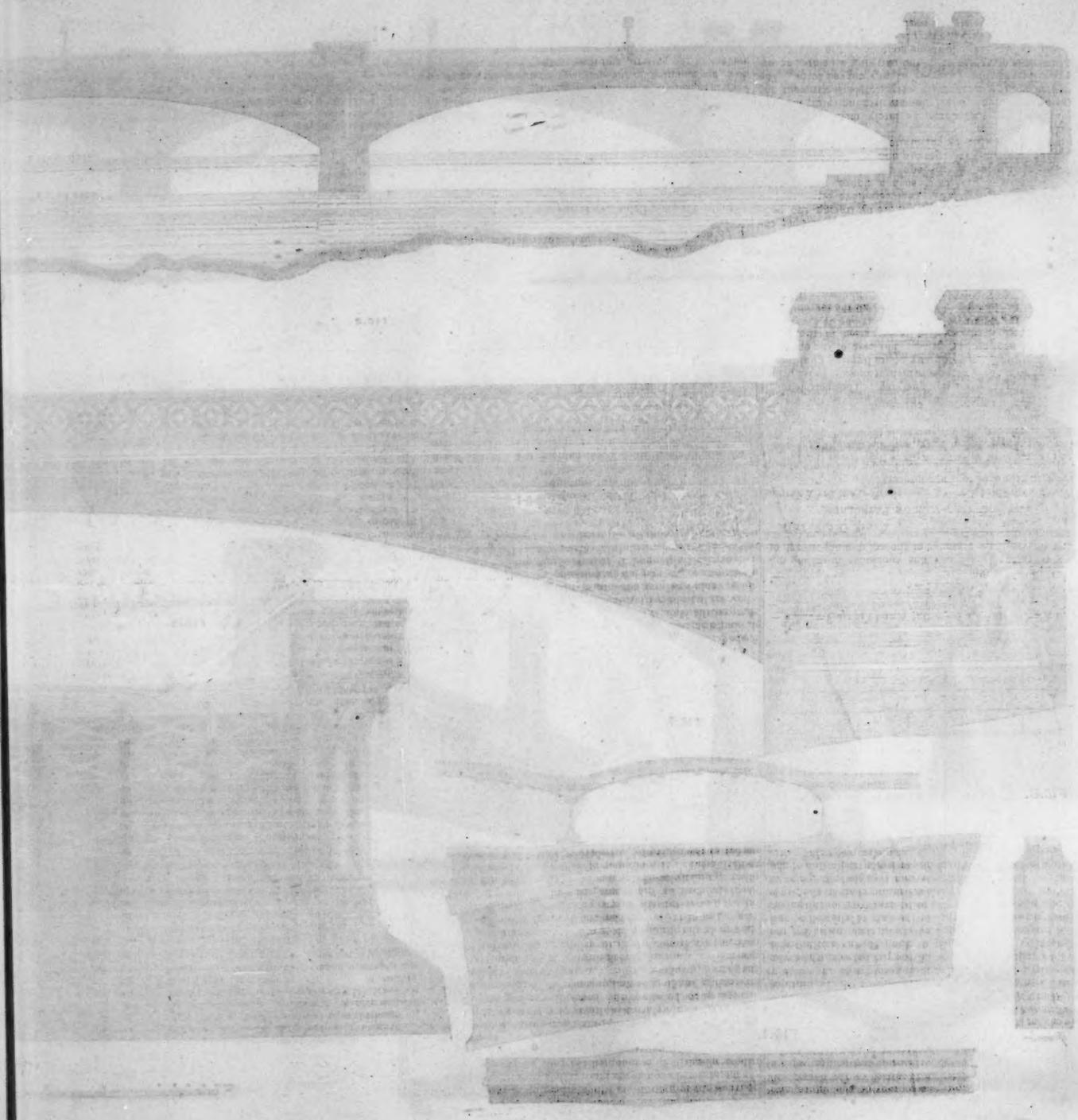
This is in remembrance of the raising of the Royal Standard at Nottingham Castle, and its subsequent gallant defence by Colonel Hutchinson against the king.

These shields are surmounted by the crown, in the form in which it was worn by Charles I.

8. The arms of Her Majesty Queen Victoria, marshalled with those of her husband, Prince Albert of Saxony and Cobourg, both shields surrounded by the Garter, and surmounted by the imperial crown.

The armorial bearings commemorate the passage of Queen Victoria and the Prince Consort over the Old Bridge, on their way from Chatsworth to Belvoir, in December, 1843, and also the chronological fact, that the New Bridge has been built in Her Majesty's reign.

* The main ribs are 3 ft. deep at the springing, and 2 ft. 6 in. deep at the crown, the mean section being of an I form 2 ft. 9 in. deep, with top and bottom flanges measuring 7 in. by 1¼ in. and 9 in. by 2 in. respectively. The form of section of the face ribs is shown on the right-hand side of Fig. 12 of our two-page engraving.



BRIDGE OVER THE RIVE

MR. M. O. TARBOTTON,

(*For Descripti*

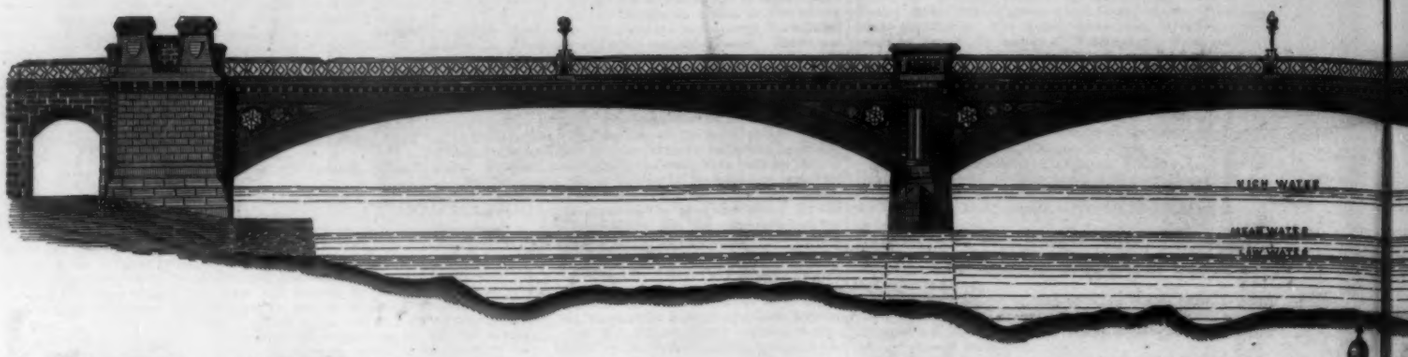


FIG.2.

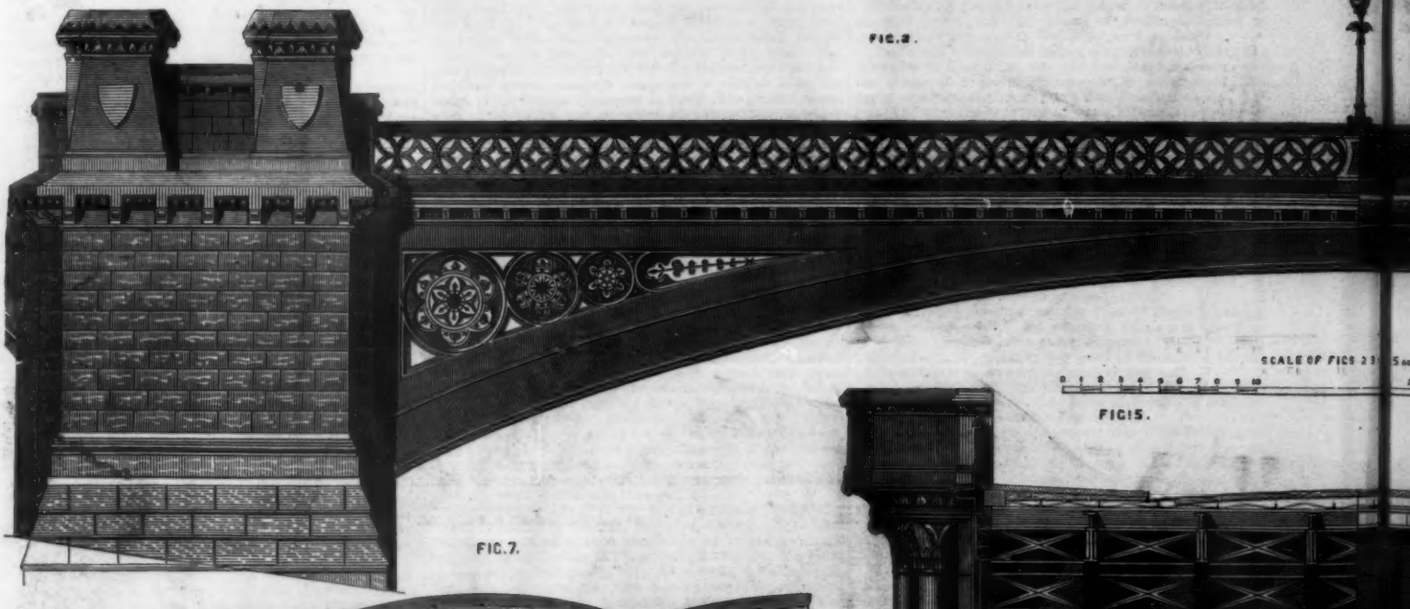


FIG.7.

SCALE OF FIGS 2 3

FIG15.

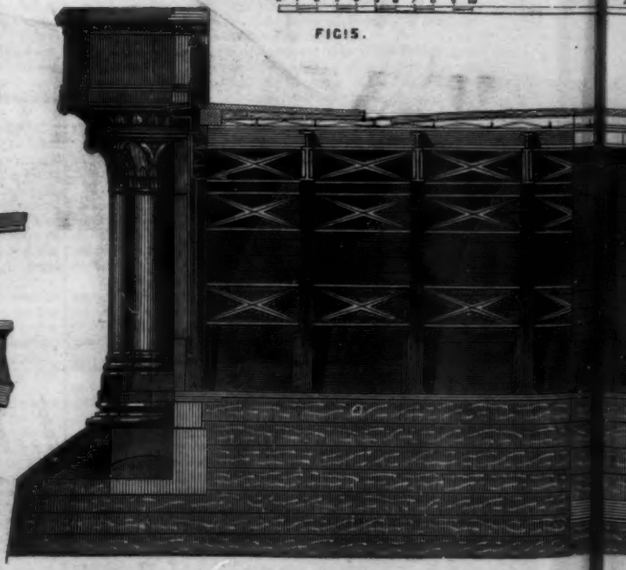
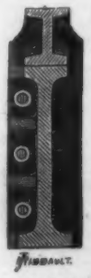


FIG.8.



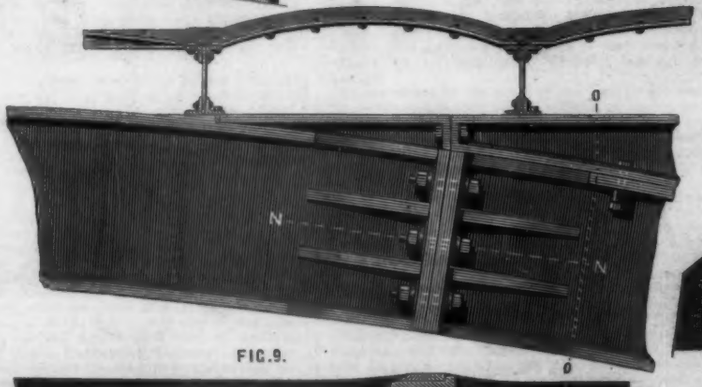


FIG.9.

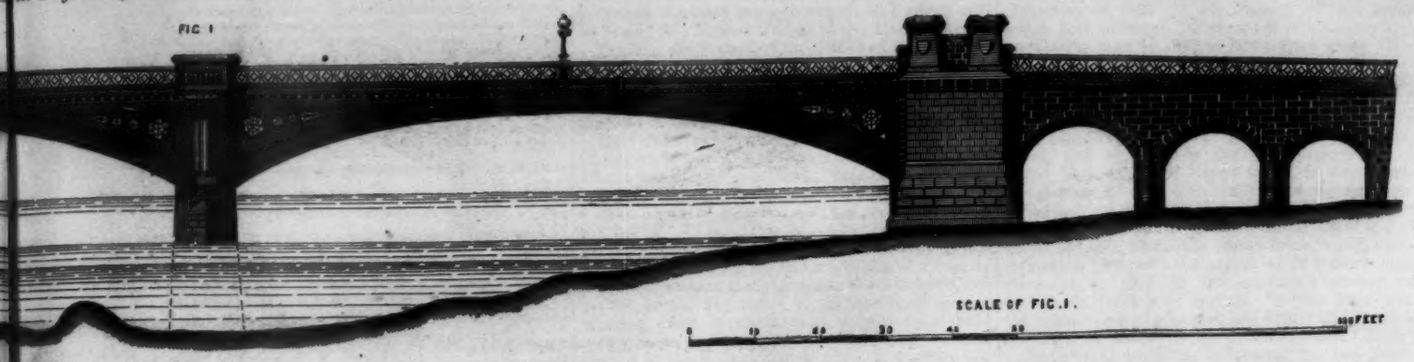
SCALE OF

TRENT AT NOTTINGHAM.

GINEER, NOTTINGHAM.

ne Page 237.)

FIG. 1

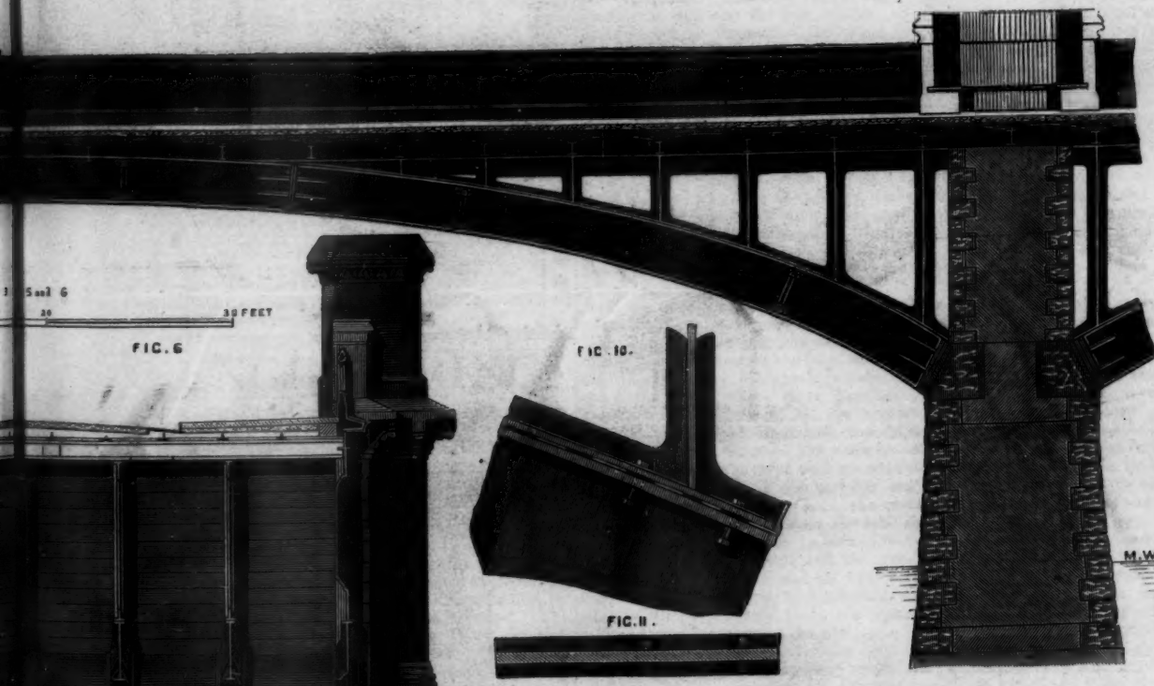


SCALE OF FIG. 1.

FEET

FIG. 3.

FIG. 4.



M.WATER

FIG. 5 and 6

FEET

FIG. 6

FIG. 10.

FIG. 11.

FIG. 12.

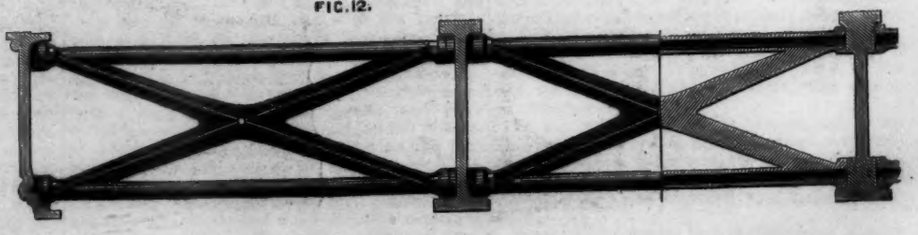
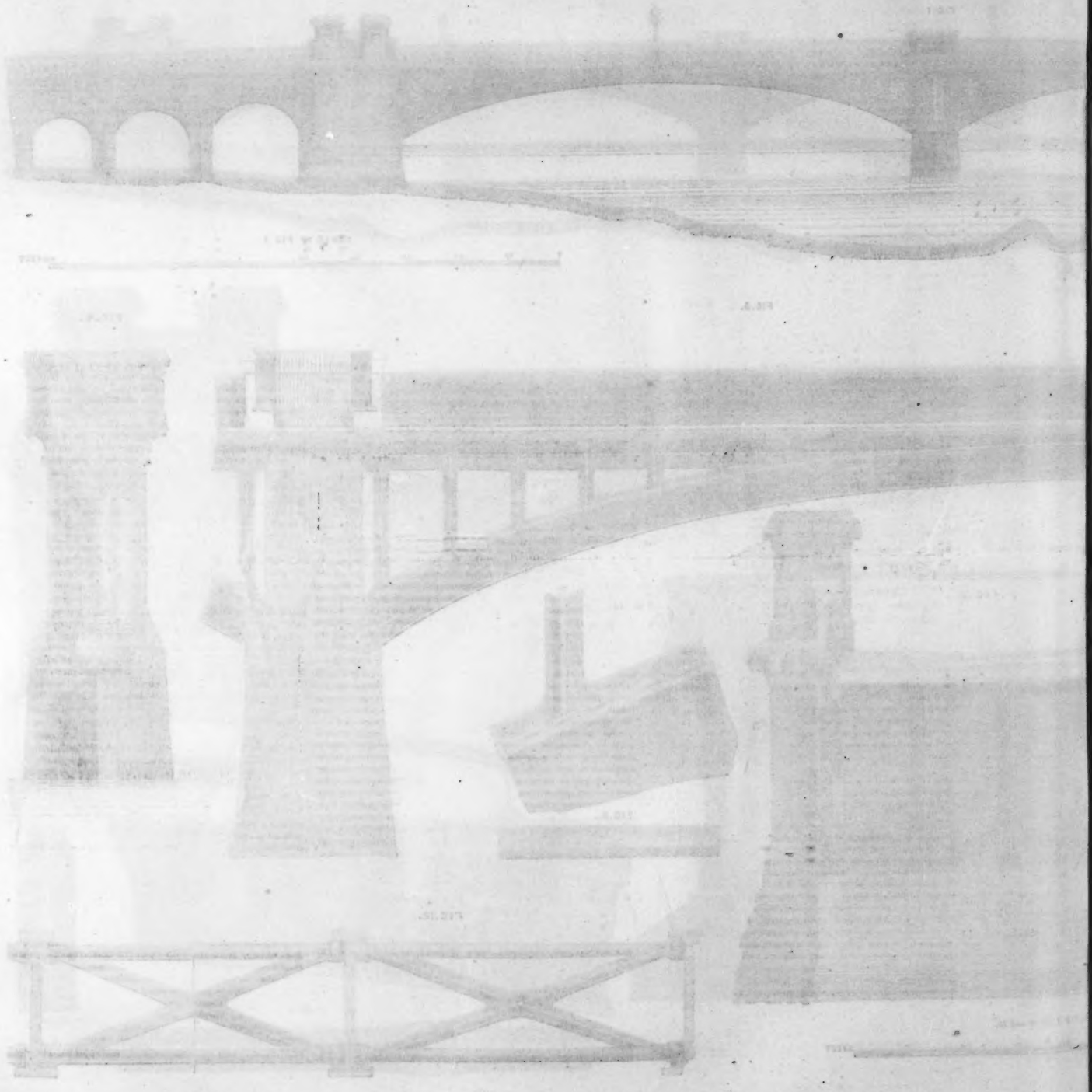


FIG. 7 8 9 10 11 and 12

FEET



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NOTICE TO AMERICAN SUBSCRIBERS.

In consequence of the great increase in our American connexion, we have found it necessary to establish a branch office in the United States. Communications may in future be addressed to MR. GEORGE EDWARD HARDING, C.E., *of* 176, *Broadway, New York, who is our accredited representative.*

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ENGINEERING.

FRIDAY, OCTOBER 13, 1871.

THE CITY OF CHICAGO.

To those who were familiar with the great and beautiful City of Chicago, the story of her rapid and so nearly complete destruction appears incredible. A marvel of progress even in a country and an age where cities spring up in grand proportions upon what yesterday was desert, she had wrested from her elder sisters, prestige, wealth, magnificence, by force of energy and help of circumstance. The capital of what was till lately the West, she was and still is the capital of the centre of the Union, she dreamt of that which before many years are over, may perhaps be accorded to her, the dignity of being the seat of Government of the United States. For the present, however, that dream has passed away, passed with her miles of avenues lined with palatial residences, of streets full of commercial palaces, hotels, theatres, churches, which yesterday were her most worthy boast, and to-day are blackened ruins, whilst tens of thousands of her population, rich and poor, young and old, men, women, and children, for the moment reduced to the same level of dire necessity, are, so say the despatches, starving in the remnant of the city. Much as first alarm may have exaggerated fact, there can be no room for doubt that the direst, deepest misfortune has swept over Chicago that has ever befallen a city in modern times, there can be no doubt that the terrible allies of such a conflagration, want and exposure, are following fast, and that even now they are most bitterly felt. To combat these latter foes neither energy nor time has been lost, help was arriving while the fire was still raging, and thanks to the large minded liberality and promptness of the Americans, no efforts will be wanting to ameliorate as much as possible the wide spread and sudden distress. And the same spirit which tendered unmeasured assistance to capitulated Paris, will be again awakened on this side of the Atlantic, and manifest itself, in the eager desire to render aid to those who are of our race, who speak our language, and are bound to us by all the ties of social and commercial intercourse. Moreover thousands in this country will be losers by the great calamity, for the business transactions of Chicago are world wide, so that the catastrophe is one in which almost universal interests are concerned, and which will be keenly felt here as well as in the United States.

Pending the arrival of the details of the devastation of the city, some particulars concerning its growth and development will be of interest, for we believe that few who are not familiar with it, comprehend its magnitude and importance.

Lake Michigan, at the southern end of which Chicago is situated, is the third largest of the great inland seas of the continent. It is 345 miles long, and 84 miles wide in its greatest dimensions, with a mean depth of 1000 ft., and an elevation above the sea of 578 ft. The so-called Chicago river, which runs through the city, is in reality only a creek, of some 250 ft. width for a length of a quarter of a mile, whence it divides into two branches, one to the north, the other to the south, gradually tapering down in width until they become quite insignificant. There is, therefore, no natural current to this stream, which ebbs to or from the lake according to the direction of the wind. Into this stagnant watercourse the sewage of the town is discharged, with the effect of causing a constant and intolerable nuisance, the sewage ultimately finding its way into the lake, which, as a natural consequence, is impurified for some considerable distance from the shore. Works, however, are nearly, if not quite, completed for changing this condition of things. There exists a canal, commencing close to the south branch of the Chicago river, and extending as far as the Illinois river, which runs into the Mississippi. This canal has been deepened, so that the water from the Chicago river may flow into it, and, by the current thus created, may carry away the sewage, and cleans both itself and the lake. For some time past this result has been partially anticipated by lifting the sewage from the river into the canal. With regard to the north branch, which would not be cleansed by the works just mentioned, it is in contemplation to flush the stream at will by the construction of a canal open or covered, communicating with the lake, and through which water shall be pumped, either from the river or the lake, as may at different times be necessary. Originally a sand-bar extended across the mouth of the river, precluding the entrance from the lake of all but vessels of light draught, but as trade increased, and ships of heavy tonnage called at Chicago, the obstruction was removed, and at the present time an available depth of 14 ft. is obtained in the harbour, but constant work is necessary to keep both the river and the entrance clear for navigation; the annual expenditure for dredging is about 11,000*l.* With the improvements of the harbour and the growth of the city, the narrow stream and its two branches became lined with wharves and indented with docks, until at the present time there are upwards of 30 miles of river frontage in the city.

From the commencement of the century till 1830, Chicago was simply a military port and a fur station. At the latter date the site was marked by a log fort, garrisoned with two companies of United States troops, twelve inhabitants, owning two stores, and three or four other houses. The only business transacted was with the Indians, who exchanged fur for spirits and other commodities, and in the winter the population retired into the fort to protect themselves from their native customers and wild animals. Two years later, with a slightly increased population, taxes were levied amounting, in the first year, to 150 dollars, of which 12 dollars were expended on the first public building erected in the city—a pound. A less inviting spot could scarcely be selected for a settlement. The wide-stretching prairie, level almost as the lake surface when unruffled, stretching out far beyond the horizon, with a slight fall from the shore landwards, was often little better than a swamp, covered with water after heavy rains, and promising little for any future use to which the locality could be put.

And indeed were it not for the great advantages which the river possessed as a commodious anchorage, Chicago at the present day would have been no magnificent city, the successful rival of St. Louis. But owning as it did advantages of harbourage, it became an eligible port for the great inland sea navigation, whilst it was easily approached by land from the east and south-east. So as the country round it became peopled, and the garden State of Illinois was gradually cultivated, Chicago naturally grew to be the depôt of the produce from the surrounding districts, the centre of their trade and their metropolis. After the final dispersion in 1835 of the Indians off the lands which had belonged to them near Chicago, the population rose in 1836 to 4100, from which time till 1841 it remained stationary, for prosperity and progress were for a time checked throughout the Union. But meanwhile the foundation was laid for what has been the staple of Chicago's commerce, the export of cattle, grain, and timber. In 1839 the exportation of salted pork and beef began to be of respectable dimensions, no less than 3000 head having been killed and packed. Thirty years later the export of hogs amounted to upwards of 670,000, and of cattle 260,000, whilst the wheat trade, which commenced in 1838 with the export of 78 bushels, had increased in 1867 to the enormous amount of 66,736,660 bushels of cereals. In the same way the timber trade developed, and with it all the other branches of commerce which have helped Chicago to her present position, and raised her population to 300,000. Meanwhile her shipping grew, and the city became the centre of a vast railway network. More than a thousand vessels trade at her port, for the most part belonging only to the lake navigation, but nearly a hundred English ships make the service regularly to and fro, crossing the Atlantic, and making their way up the St. Lawrence, and through the Welland Canal to Lake Michigan, a distance of 1261 miles. Compared to the regular lake vessels, these ships are of small tonnage, being limited by the dimensions of the canals through which they have to pass.

The city, as it stood before the fire, extended for some eight miles along the bank of the lake, stretching inland for a depth of four miles. The whole of this area is not, of course, entirely built over, but the greater part of it was covered, in the business and residential quarter, with magnificent buildings of iron and stone, whilst many wooden structures existed in the inferior districts. In the suburbs similar buildings, of more or less pretensions, are the rule, and wooden pavements, to the presence of which, rightly or wrongly, the rapid spread of the flame is attributed, have an extent collectively of about 40 miles. Laid out for the most part in rectilinear blocks, after the fashion of all modern American cities, there existed noble avenues running north and south, with broad streets crossing them at right angles. Till lately the several lines of railway which had their depôts in the heart of the city, ran trains across some of the finest streets and avenues at the street level, even in the most crowded quarters. The danger and inconvenience attending this custom were, however, too great to permit a larger continuance of the evil, and viaducts were in course of construction to separate the railway from the street traffic by raising the former to a higher level. Great improvements and alterations were also being made in the communication across the river. Already one subway had been built, connecting East and West Washington-streets under the south branch of the river, and another was in course of construction. Doubtless this means of communication will in the future, to a great extent, supersede the swing bridges which are constantly being opened to admit the passage of the vessels which throng to and fro incessantly. There are twenty-seven of these bridges altogether owned and worked by the city, ten entirely of wood, the others either of iron, or of timber and iron.

Of the warehouses, banks, stores, and public buildings, the churches, hotels, theatres, and residences, which so lately were the glory of the city, all that is needful to say is that they were such as American taste and unlimited wealth always produce.

It may be interesting here to make some allusion to the city water works not long since completed by Mr. E. S. Chesbrough. To obtain a supply of water uncontaminated by the sewage that finds its way into the lake, it was resolved to drive a tunnel some 5 ft. in diameter beneath the bed of the lake for a distance of two miles, and to terminate the

tunnel with a vertical shaft enclosed within a timber crib moored in the lake. Penstocks in the crib and shaft, regulated the supply as desired. The engines on the lake bank drew the water from the tunnel, and forced it up a standpipe some 150 ft. in height, so that a sufficient head of water was obtained for supplying the whole city. This bold and decidedly original piece of engineering was most successfully completed in the beginning of 1867, since which time, with the exception of a few temporary stoppages from the accumulation of ice at the inlets during the winter months, the city has been regularly supplied. Supplied, too, in a very prodigal manner, the daily average throughout the year being in 1870 some 18¼ million gallons, and in the driest months over 20¼ millions a day. Already the great consumption of water was attracting the attention of the municipal engineers, and failing a more economical employment, an extension of works was contemplated, as the engines worked continuously, the total time of stopping in the year being only 67 minutes.

The water is supplied to the city through some 250 miles of mains, the largest of which is 28 in. diameter. As the water works are on the north side of the river, and as it is impossible to carry the supply mains thence above the water level on account of the navigation requirements, the mains cross the bed of the stream. In 1869 a serious accident occurred by which the water supply was temporarily interfered with, an anchor having struck and fractured the pipe, causing much inconvenience and trouble before it could be repaired. It is very probable that these mains might have been injured at the commencement of the great fire, and the supply of water thus cut off. It is certain that the water works themselves could not have suffered early in the conflagration, as their locality would insure their temporary safety.

The low-lying ground on which Chicago stands, rendered for a long while the conditions of drainage almost intolerable; there was no sufficient fall to be obtained even to drain into the stagnant creek. Nothing remained, therefore, but to regrade the streets, to raise them as much as necessary to get sufficient fall. Much money and labour were expended on this work, and the principal portions of the city were thus improved. But altering the level of the streets interfered with the houses on each side of them, the doors of which were no longer on the street level. Many were pulled down and rebuilt, but most were too costly for destruction. Skill and ingenuity were called into play, and buildings were raised bodily to the new level—in some cases 8 or 10 ft. In this way warehouses of iron, or of stone, six or seven storeys in height, and weighing 16,000 or 20,000 tons, were lifted with the greatest facility, and without accident. From that time house raising has grown into a trade in Chicago; new storeys are added to buildings, not from the garrets, but from the basements, and—a branch of the same business—buildings are removed bodily to sites more commodious than they previously occupied.

Chicago has been truly a city of wonders, in her growth, her commerce, her wealth, and her people. Her engineering works have been of necessity paradoxical to meet requirements unknown elsewhere, and they have been planned and executed with a skill and boldness that has never yet failed. And though at present she is a heap of ruins, though 100,000 of her people are homeless, and beggars, and all that was richest in her has been snatched by the flames, there remains the indomitable energy, the active and untiring hands, that cannot be quelled even by such a visitation, and the time will not be long ere a second Chicago will arise almost upon the warm ashes of the first, still grander than the one which has been swept away. In no other country, and to no other people, would this thing be possible.

MECHANICAL FALLACIES.

There is a fashion in opinions as well as in clothes, and as we find the cast-off garments of the "upper ten" descending we know not how low, so also views long since discarded as untenable by scientific men still linger in the classes beneath them. Garments and ideas are both altered to suit the wearers, so much so, indeed, as not to be recognised at first sight. This has been the case with "perpetual motion," that will-o'-the-wisp which has constantly eluded the grasp of the inventor at the very moment of success, and has in many cases brought down his grey hairs with sorrow to the grave. It is very generally supposed that the belief in perpetual motion, like the belief in witchcraft, has died a natural death; but this is not the case. It is as flourishing as ever but in a somewhat different form, and the title "improvements in motive power" covers any number of mechanical fallacies. The patent records furnish some instructive information on the subject, and we will take the year 1866 as an example. In that year sixty-four patents were granted for obtaining motive power, and twenty of these depend for their presumed action upon the simple principle that 2+2 is greater than 4. They are not only self-moving machines, but they supply power to drive others. It is quite unnecessary to mention them all in detail, but we may speak of a few of them. It is the old, old story. One "engineer" has a wheel provided at the extremities of the arms with flexible bags weighted at one end. The bags open and fill with air as they arrive at the bottom, and the air is forced out as the wheel brings the weighted end uppermost. A "mechanician" patents "a combination of levers and rods" fearful to contemplate, "whereby a greater amount of power is rendered available for use and aiding to overcome the resistance." Another inventor speaks of a "power-creating wheel," which consists of a wheel having a tube of vulcanised india-rubber secured on a portion of its outer periphery, the ends being connected with the hollow axle to which the wheel is attached. The other wheel has an elastic tube on the opposite portion of the periphery, so that one tube may always be undergoing compression. By this means a supply of compressed air is obtained, which, says the enthusiastic individual who proposes the plan, "is the power I use for driving or propelling such engine, carriage, or apparatus." One inventor proposes to gain power by means of a weight revolving at a high velocity, whilst another lays down this principle: "any body being plunged in a liquid is submitted to two opposite forces; first, its own weight which tends to lower it; secondly, the pressure of the liquid which tends to raise it with a force equal to the weight of the liquid displaced by the body. The difference between these two forces" is the motive power which the inventor proposes to use. On the principle of "having one's cake and eating it," a weak-minded enthusiast attempts "to produce motive power by the force of steam acting on a reaction and direct action wheel, both, however, at the same time." In other words his machine consists of the toy known as "Hero's steam engine" combined with Branca's engine. Another equally greedy individual utilises the force of the steam expended on the bottom and top of the cylinder during the up-and-down strokes of the piston, "which is effected by causing the steam cylinder to slide in the reverse direction to the piston." What, however, is most amusing, is the self-satisfied air of the motive-power man, when he condescends to argue. We will take, as an instance, the author of a machine, the name of which perhaps indicates to some extent the "cloudy" condition of the inventor's mind, and which is described in the specification as "an engine manufacturing a power," and of which it is stated that it "constitutes that desideratum so thoroughly 'tabood' in its assumed impracticability of attainment, that scientific bodies have in instances determined to consider no such question"—and quite right too. The inventor then proceeds to develop his theory at length. Sceptics are disposed of in the following short and easy manner. "To anyone not educated to the point of incapacity for such a consideration, the demonstration given above would appear amply sufficient. But as a rule the difficulties of surmounting an established creed, which has become a part of the being of its professor are as insuperable as would be the difficulty of making an intelligent Christian out of an intelligent Mahomedan."

We will give one more instance of the eccentricity of the inventorial mind. A patent was granted in 1864 (No. 2811), for "improvements in developing heat, boiling water, and generating steam." It took two geniuses to accomplish the invention, the one a surgeon and the other a "gentleman." They propose to use a boiler surrounded by rubbers, worked in the first instance by an auxiliary engine. The friction of the rubbers against the boiler will, say the inventors, generate sufficient heat to boil the water and get up steam. So far, good. As a philosophical experiment, such an arrangement is by no means an impossibility. "When the power of the steam in the boiler before mentioned," the specification goes on to say, "is sufficiently developed, the machinery connected with it can be set in motion to secure a similar revolution of wheels or motion of blocks, and the fire in the small engine first mentioned may be let out, and the means used to create the primary motive power discontinued"! The surplus power obtained in this manner is to be applied to any purpose which may be desired. It is worthy of remark that the law officer who passed this patent was Sir Roundell Palmer, who, it should be noted, is strongly opposed to the existence of a patent law. It can hardly be said that he passed the present application by inadvertence, inasmuch as he actually ordered the description originally deposited by the inventors to be amended.

We are not just now advocating any change in the law, but we are justified in asking that two public servants, each receiving an annual income of from 5000*l.* to 6000*l.*, shall do their duty, and that the solemn farce of protecting, year after year, the very same ridiculous "inventions" by an instrument under the Great Seal may be discontinued. It is only fair to say that the recent agitation for patent law reform has, in some degree, goaded the law officers into a feverish activity. In one case which lately came under our notice, an inventor mentioned that the principle on which his machine was founded was that enunciated in "Mariotte's Law" which he subsequently alluded to as "that well-known law." The law officer objected to this, struck it out of the specification, and said, "let us have nothing about 'well-known laws.' Put it in plain English, so that a plain man can understand it."

It is quite obvious to all unprejudiced minds that the legal and political qualifications of a law officer are of little use, when technical questions often of extreme difficulty and importance have to be considered. We trust that the Select Committee on Patent Law when dealing with the very delicate question of previous examination will bear these facts in mind.

THE PALLISER-PARSONS BOLT.

We have, on various occasions, noticed the special forms of bolt which were first introduced by Major Palliser, and later by Mr. P. M. Parsons, with the object of obtaining more uniform strength, and greater elasticity, and of avoiding the extension of the screwed portion, a universal evil in bolts of the ordinary form, when exposed to constantly recurring strains and shocks, such as in the fastenings of permanent way. Major Palliser, so early as December, 1863, introduced the improved bolt for armour plate fastenings, with remarkable success, and various trials proved its undoubted superiority over ordinary fastenings, which not unfrequently broke through the screwed part by the force of concussion, and without being struck, whilst the former resisted well both shot and shell, and yielding through the shank when they failed. The same principle, applied to railway fastenings, was also found to answer most successfully.

Afterwards, came Mr. P. M. Parsons with a patent bolt for effecting precisely the same thing, and substantially in the same manner as Major Palliser had done, though this later plan possessed some decided advantages over the former. Unfortunately, the interests of these two gentlemen conflicted, and for several years past a really useful modification has been lying idle, because satisfactory arrangements could not be effected. We are glad, therefore, to find that at last an understanding has been arrived at, whereby all hindrance to the manufacture and use of the improved bolts are removed, and they will probably therefore come rapidly and largely into use, particularly for railway fastenings, for which they are especially valuable.

It will be remembered that Major Palliser simply reduces the diameter of the shank of the bolt until it becomes of a section uniform with the screwed portion, in order that the strength of the bolt may, as far as possible, become uniform throughout, and that the extension under strain, which in ordinary forms invariably takes place in the screwed part, to the destruction of the thread, may be transferred to the shank. Thus not only is the thread preserved, but as the bolt is more elastic it is slower in taking a permanent set. Mr. Parsons, on the other hand, effects exactly the same result by reducing the area of the shank without reducing the diameter as in Major Palliser's method. He chamfers or grooves the shank of the bolt on four sides, so that the bolt becomes cruciform in section for a portion of its length. By this means the fit

of the bolt in the hole through which it passes is secured, an advantage not found in the bolt with a simply reduced diameter.

Numerous experiments by Mr. Kirkaldy and others on both forms of bolts, to say nothing of a lengthened experience with them in fastening armour plates and in permanent way, have proved conclusively the advantages that are secured. Nor indeed could it be otherwise, considering that a proper proportion between the shank and the screwed portion of the bolt is obtained, that by reducing the former an undue strain is no longer thrown upon the latter, and that a maximum amount of elasticity can be obtained. This last qualification not only secures the bolt under all ordinary circumstances from becoming permanently extended, but it also permits of an initial tension, being placed upon the nut when it is screwed up, thus increasing its grip, and counteracting the tendency to run back, under repeated shocks, as fish-bolts do, beneath passing traffic, whilst, as the distortion of the screw threads is prevented, the nuts cannot shake loose.

It is to be regretted that this useful improvement has been so long in abeyance. It is, however, needless to point out that although it has not yet come largely into use, for the reasons given above, the time that has elapsed since its first introduction has been well employed in testing its real value.

MONT CENIS TUNNEL.*

Compressed air, and indeed almost all gases moving along a tube, encounters a certain amount of resistance owing to friction.† If we represent by L the length of the tube, and D its diameter, the loss of pressure occasioned by the friction alluded to, is represented by

$$H-h=K\frac{L}{D}\frac{v^2}{2g},$$

where H and h are the pressures at the beginning and the end of the tube, measured in columns of the same gas, at the density it has at the section at which the velocity, v, is taken, and where K is a numerical coefficient (the coefficient of friction = 0.0236), and g is the accelerating force of gravity.

Let H_1, H^1, and h be respectively the pressures in the reservoir at the starting, near the orifice of outflow, and externally, measured in columns of gas of the density of the gas in the reservoir, D and d being the diameter of the tube, and of the orifice by which the gas flows out; further, φ ψ, the coefficients of contraction at the entrance into the tube, and at the orifice of escapement, and K that of friction, as said above; v the initial velocity in the tube, $\alpha+t'$ the absolute external temperature, and $\alpha+t$ the absolute temperature of the reservoir.

The general equation of the motion of the gas in a rectilinear tube of uniform section will be,

$$H-h=\frac{v^2}{2g}\left\{\left(\frac{1}{\varphi^2}-1\right)+K\frac{L}{D}+\frac{D^4H(\alpha+t')}{\psi^2d^4H^1(\alpha+t)}\right\}$$

To obtain the pressures measured in columns of mercury, if P_1 P^1 and p are the heights of mercury equivalent to H H^1 and h of gas; and δ being the tubular density of the gas, we shall have

$$H.\delta\times1{,}8\frac{P}{0{,}760}\frac{\alpha}{\alpha+t}=13596\,P,$$

whence

$$H=7990\frac{\alpha+t}{\alpha\delta},$$

and

$$H-h=H\left(1-\frac{h}{H}\right)=7990\frac{\alpha+t}{\alpha\delta}\left(1-\frac{p}{P}\right),$$

and the equation of the movement of gas shall become

$$P-p=\frac{\alpha\delta P}{7990(\alpha+t)}\left\{\left(\frac{1}{\varphi^2}-1\right)+k\frac{L}{D}+\frac{D^4P(\alpha+t')}{\psi^2d^4P^1(\alpha+t)}\right\}\frac{v^2}{2g}$$

If we wish to have the volume of the outflowing gas at every second, respectively at the temperatures and pressures P and t, and p and t', they will be given by

$$Q=\varpi\frac{D^2}{4}v \text{ and } Q^1=\varpi\frac{D^2}{4}\frac{P(\alpha+t')}{p(\alpha+t)}v.$$

The exactness of these formulæ at low and middling pressures, has been sufficiently proved by the results of the experiments made.

To illustrate them, let us apply them to air moving in tubes of 0.01028 metre diameter, of the length between 0.07 and 18 metres, allowing the air to flow freely into the atmosphere under a constant pressure of one atmosphere, we shall have $\delta=1$ and $\psi=1$ and P^1 very approximatively equal to P; further assuming $\frac{1}{\varphi^2}-1=1.475$, i.e., $\varphi=0.636$ and $t=t'=20°\frac{1}{\alpha}=\frac{1}{250}$, instead of $\frac{1}{273}$ in order not to neglect the aqueous vapours existing in air, we shall have

$$Q^1=410{,}405\,\varpi\frac{D^2}{4}\frac{P}{p}\sqrt{\frac{1-\frac{p}{P}}{2.475+0.0236\frac{L}{D}}}$$

in which we shall make $\frac{p}{P}=2$ and D = 0.01028. The following Table gives the results calculated with this formula by M. Cavallero:

Length of the tube (L).	Values of Q^1 (volume of the out-flowing gas) by experiment.	Values of Q^1 by calculus.	Differences.
metres.	metre cube.	metre cube.	metre cube.
18	0.00724	0.00719	0.00005
9	0.00989	0.00989	0.00000
4.50	0.01380	0.01331	0.00049
2.25	0.01721	0.01727	0.00006
1.125	0.02032	0.02127	0.00095
0.562	0.02480	0.02471	0.00009
0.281	0.02760	0.02720	0.00040
0.14	0.02869	0.02876	0.00007
0.07	0.02869	0.02965	0.00096

From the experiments made on this subject the following empirical has been deduced:

$$v=\frac{2225}{\varpi\frac{D^2}{4}}\frac{p}{P}\frac{\sqrt{D^5(P-0.76)}}{L+42\frac{D^5}{d^4}}$$

which serves to the determination of the velocity, v, at the origin of the tube.

The experiments made on the hydro-pneumatic compressor of Messrs. Sommeiller and Grattoni (to which I alluded in my last letter), have proved that the formula given above does not hold for high pressures.

The same fact can be demonstrated theoretically. The loss of pressure owing to friction is expressed by

$$\frac{P-p}{l'}=\frac{\alpha\delta}{7990(\alpha+t)}K\frac{L}{D}\frac{v^2}{2g},$$

whence

$$P-p=\frac{\alpha\delta K}{7990(\alpha+t)}P\frac{L}{D}\frac{v^2}{2g}.$$

If we now consider separately two portions of tube of the respective lengths of L_1 and L_2; and if P and P^1 and P^1 and p the initial and final pressures of the two portions, v and v^1, the velocities at the end of the lengths, L_1 and L_2, we shall have, when applying the last formula,

$$P-P^1=\frac{\alpha\delta K}{7990(\alpha+t)}P\frac{L^1v^2}{D\,2g},$$

and

$$P^1-p=\frac{\alpha\varrho K}{7990(\alpha+t)}P^1\frac{L_2v^2}{D\,2g}.$$

$$P-p=\frac{\alpha\delta K}{7990(\alpha+t)}\frac{}{2gD}(P\,L_1v^2+P^1L_2V^1{}^2)$$

The temperature in the tube being constant,

$$Pv=P^1v^1,$$

hence

$$P-p=\frac{\alpha\delta K}{7990(\alpha+t)}\frac{}{2gD}(L^1v+L_2v^1).$$

Now, as

$$v^1=v+(v^1-v),$$

we have

$$P-p=\frac{\alpha\delta K}{7990(\alpha+t)}P\frac{L}{D}\left\{1+\frac{L_2(v^1-v)}{Lv}\right\}\frac{v^2}{2g},$$

which is different to the one found above for low pressures, and the difference is directly proportional to the difference between P and P^1.

Before leaving this subject, I wish to lay before your technical readers some very simple formulæ presented to the Royal Lombard Institute by M. Cagnoni, which are probably unknown to them. M. Cagnoni started from D'Aubuisson's simple formula:

$$A-a=0.0238\,a\frac{L\,d^4}{D^5},$$

where a and A are the manometrical heights of mercury at the end and at the beginning of the tube; d the diameter of the opening of outflow, D the diameter, and L the length of the tube, putting D = 006m., and L = 400m. (which were the conditions of the experiments made on Messrs. Sommeiller and Grattoni's hydro-pneumatic compressor), D'Aubuisson's formula becomes

$$a=A\frac{1}{1+123430000\,d^4}$$

when the results given by this equation were calculated, they were found two or three times higher than those the practical experiments gave.

M. Cagnoni then made the hypothesis that an elastic fluid, flowing out from a long tube of constant diameter, and under a permanent pressure, with velocity and density different in the various sections, would behave approximately as a liquid, which would have a uniform velocity equal to the medium of the velocity of the fluid corresponding to the extremities of the tube, and a uniform density also equal to the medium of the densities corresponding to the same extremities; starting from this hypothesis M. Cagnoni deduced:

$$A-a=0.000000103\delta\frac{L}{D}u^2$$

in which A and a are the pressures in metres of a column of mercury at the beginning and at the end of the tube; δ and u the media density and the velocity as explained above.

Applying this formula to the determination of the coefficient

$$0.000000103\delta.$$

M. Cagnoni found the following numbers substituting for A, a and u the values taken from D'Aubuisson's experiments,

$$0.000000103\delta=0.0000001318$$
$$0.0000001311$$
$$0.0000001317$$
$$0.0000001325$$
$$0.0000001352$$

medium value 0.0000001326

This would show that the formula under the above hypothesis is applicable to low pressures.

M. Cagnoni, however, comparing the results given by his formula with those obtained in the experiments made on Messrs. Sommeiller and Grattoni's machine, proved that it is also very approximatively applicable to high pressures.

The following Table clearly shows it:

Velocity at the origin of the tube.	Difference of pressure (A − a) obtained in practice.	Deduced from the formula.
1.012	0.0039	0.0046
3.197	0.0457	0.0459
3.604	0.0577	0.0571
4.106	0.0738	0.0758
4.415	0.0853	0.0877
10 157	0.3660	0.4641
15.100	0.9030	1.0260
18.460	1·5560	1.5330

The formula itself is transformed in

$$A-a=0.0188\frac{b+a}{(b+a_1)^2}\frac{L\,d^4}{D^5},$$

introducing in it, instead of the medium velocity, a function of the diameters D and d of the tube, and of the opening of outflow and in which $b=0.76$ $a_1=\frac{1}{2}(A+a)$, L = length of the tube, and A and a keeping their former meaning.

Introducing further the quantity Q of fluent air reduced to the volume of ordinary atmospheric density, M. Cagnoni deduced

$$(b+a)^2=(b+a)^2+M\frac{L}{D^5}Q^2,$$

in which M is a numerical coefficient which may be taken = 0.0000002567.

Francis Kossuth, C.E.,
Royal Commissioner for Railways in Italy.

LITERATURE.

Elementary Treatise on Natural Philosophy. By A. Portat Deschanel. *Translated and Edited with extensive Additions.* By J. D. Everett. Part I. London: Blackie and Son.

Two out of the four parts which will complete this series of handbooks on Natural Philosophy have already appeared, and, if those yet to come are to be equal to the others, the four volumes will form the best series of this kind ever yet published.

The talented author, late Professor of Physics in the Lycée Louis-le-Grand, and Inspector of the Academy of Paris, has been fortunate enough to meet with a translator and editor capable, not only of doing him justice, but also of improving the happy style in which the original treatises are written. With reference to this original, we cannot do better than quote the words of Mr. Everett in his preface to the first part. He says: "The

* For last article see Engineering, page 180.
† Memoir of G. B. Cravesana, C.E.

treatise of Professor Deschanel is remarkable for the vigour of its style, which specially commends it as a book for private reading. But its leading excellence, as compared with the best works at present in use, is the thoroughly rational character of the information which it presents. There is great danger in the present day lest science-teaching should degenerate into the accumulation of disconnected facts and unexplained formulæ which burden the memory without cultivating the understanding. Professor Deschanel has been eminently successful in exhibiting facts in their natural connexion, and his applications of algebra are always judicious." The first part of the series deals with mechanics, hydrostatics, and pneumatics; it is divided into a number of short paragraphs, and is illustrated by 181 engravings on wood. Touching these engravings, we may say that they are distinguished by the special beauty and usefulness only to be found in French handbooks. They are beautifully executed, and happily conceived, placing every subject upon which they refer graphically before the student, and aiding him to comprehend the questions under consideration, as much as if he were assisted by models or by actual machines. The preliminary chapter is devoted to a consideration of the definition and the application of natural philosophy, and the second, which commences the branch of mechanics, investigates the principle of inertia and the elements and properties of force. Step by step the student is led on to the theory of the composition of force, and is assisted by drawings of different apparatus for illustrating the resolution of forces followed by actual and familiar instances.

The constitution of bodies, solid, liquid, and gaseous, is next considered, their various properties and specialities are pointed out, with the phenomena of expansion, contraction, elasticity, &c. Naturally, the examination of the force of gravity comes next, and this, besides being investigated with the utmost clearness and skill, is illustrated in a score of different ways; then follows an investigation of the laws of falling bodies, of the pendulum, and the balance, all carefully and very fully considered, yet so clearly and judiciously, that the student is led on, insensibly, to the acquirement of a vast amount of information condensed within very narrow limits. In the same way the question of hydrostatics is carefully and fully investigated in a series of chapters, and the theories, practice, and phenomena of pneumatics complete the volume. That so much can be compressed into so small a space is in the natural wonder of the student of this little work, and were it not for the admirable manner in which the author writes, and has been translated, not one-fourth part of the information could have been brought within the space. It is a noteworthy feature of the book that all the principal philosophical instruments employed in the investigation of the three branches of science which form the subject matter of the book, are carefully delineated, and their actions explained; by this means the student is greatly aided, and obtains more by mere investigation than could be conveyed by the most careful description. The most simple and familiar phenomena are seized for giving examples of the special points to be explained, and none but a master's hand could turn them to so good an account. The use of formulæ is very sparing, and those which are given are of simple form, so that there is no difficult reading throughout the book. For every reason this cheap hand-book of natural philosophy is one most earnestly to be recommended to the student, and equally to the more general reader, who will find therein a very large fund of information, and ample food for suggestion. We look forward anxiously to the publication of the third and fourth parts of the series. The second, as we have already said, is in the hands of the public, and we shall refer to it on an early opportunity.

On the Application of Iron to the Construction of Bridges, Girders, Roofs, and other Works. Showing the principles upon which such structures are designed and their practical application. Especially arranged for the use of students and practical mechanics, all mathematical formulæ and symbols being excluded. By Francis Campin, C.E., &c. With numerous illustrations. London: Lockwood and Co.

This is another of the series of handy little practical manuals which we lately mentioned as being in course of publication by Messrs. Lockwood. The scope of the work is fairly expressed by its title, and the promises made in the latter are well fulfilled. Mr. Campin deals with his subject in a well chosen style, and the rules which he gives are very clearly stated and their application fully explained by examples. The book will be a useful addition to the libraries of those who, from their imperfect acquaintance with mathematics, are unable to use the higher works on the subject.

AN ORIGINAL SUGGESTION.

Last week there appeared in our contemporary, *The Engineer*, an article criticising the construction of heavy ordnance as proposed some time since by Mr. Bessemer, and lately illustrated and described in this journal. Without stopping to discuss that article, we may remark that our contemporary exhibits some characteristic misplaced energy in falling foul of an arrangement which, as we stated, has during the last few months undergone essential changes. But we cannot refrain from calling attention to one of those original suggestions our contemporary is so fond of making, and which, as a rule that scarcely knows an exception, are old or worthless, often both. Thus they republished last week in the course of the article upon the Bessemer gun, an extract from their own journal for the 21st June, 1867, containing a new idea, or, to use their own favourite formula, a proposition "we believe made now for the first time," for the construction of heavy guns, with a central and annular powder chamber, as shown in the sketch, Fig. 2, which is reproduced from their own engraving. Now, as everybody knows, who makes the least pretension to information upon matters connected with ordnance, this suggestion had been, at the date of its first publication in *The Engineer*, patented by Mr. Lyman in the United States, and was described and illustrated in the *Mechanics' Magazine* for February 14th, 1867, four months only before *The Engineer* reproduced it as their own idea. The arrangement, which is well known, is shown in Fig. 1, and it is identical, so far as the arrangement of powder-chamber is concerned, with the so-called Fitz-Maurice gun.

FIG. 1.

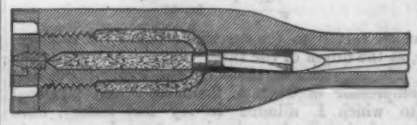
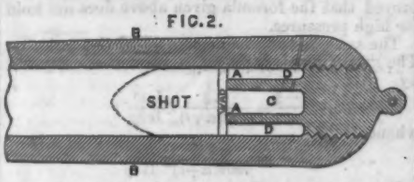


FIG. 2.



This "original suggestion" reminds us of another which appeared recently in the columns of *The Engineer* upon the construction of armour-plated defences. It was proposed, "and we believe for the first time," that the outer plate and the backing should be separated by a certain or uncertain space "full of air," so that shell striking the outer plate should be exploded, and if it passed through, should expend its expiring forces against the second line of defence, which would not only be kept intact, but would act as a shield to ward off the fragments that now find their way through the outer plates and backing. If our contemporary will turn to the published transactions of the Institution of Naval Architects for 1867, vol. viii, page 117, they will find their original suggestion embodied in a paper by Captain L. G. Heath, together with the subsequent discussion. The only difference between Captain Heath's proposition, and that of our contemporary is, that the former, although open to fatal objections, was practically worked out, whilst the latter was not.

Expense on Fortifications.—A return to the House of Lords has been printed (obtained by the Duke of Somerset), showing that since the year 1850 on the fortifications in the Isle of Alderney 262,730*l.* had been expended.

Continental Railway Fares.—By a decree of the French Government just passed, a tax on locomotion will come into operation on the 15th of October, 1871. In consequence of this Act the fares on all the French railways will be raised 10 per cent., and the charges for all public conveyance similarly augmented. On and from the 1st of November, 1871, the fares on all the state railways of Belgium will be revised; those for short and intermediate distances being lowered, and those for long distances increased. The fares will be on the equal mileage principle; the charges per kilometre for the three classes standing as follows: 7.2c. first class; 5.4c. second class; and 3.6c. third class; equal to a fraction over 1d. per mile first class, ¾d. second class, ½d. third class. The express fares will be 25 per cent. in excess of the ordinary fares, and in consideration of the increased rates for long distances return tickets at a fare and three-fifths will in future be issued (first, second, and third class) to and from all stations, available for one or two days, according to distance. The main line from Warsaw to Moscow (*vid* Brest and Smolensk) is now open throughout. The new line from Freiburg to Alt Breisach, in the Grand Duchy of Baden, is now open for passenger traffic.—*Bradshaw's Continental Guide.*

THE GATLING GUN.

When describing and illustrating the Gatling battery gun some months since,* we mentioned that Sir William Armstrong and Co. had received instructions from the Government to manufacture a limited number of these important adjuncts of our army and navy, for experimental purposes. It is, however, only recently that the production of these weapons has been proceeded with, on account of the delays which have occurred in determining the diameter of the bore, the nature of the rifling, and the description of cartridge to be used. These points have, however, at length been settled, and the guns at present ordered will be rifled upon the Henry principle, the calibre of the bore being .45, so that the ordinary service rifle cartridges can be used upon an emergency. Solid drawn cartridges, however, are to form the ammunition of the gun, as it has been found that the Boxer cartridge is liable to have the base torn from the body of the case by the extractor, the metal case being left in the chamber. Thirty-six of these guns have been ordered, a portion being for the War Office and a portion for the Admiralty. When completed they will be distributed in various branches of the army and navy for experimental practice. Should they be found to answer the requirements of the service, their manufacture will be further proceeded with, and any modification suggested by practice will be introduced. It is probable that in some of these machine guns a larger calibre will be adopted by the Government. For certain purposes, such as for use in casemated forts or garrison batteries, the heavier guns would probably prove the most useful. All the weapons are being constructed with the most recent improvements, as described by us in the article to which we have already referred.

MECHANICAL PUDDLING.

In our article on the recent meeting of the Iron and Steel Institute at Dudley, it was mentioned that the question of sending out a Commission to America to investigate the real merits of this mechanical puddler, was referred for the consideration of the Committee on Mechanical Puddling, and it was very clear that the feeling of the meeting was almost unanimously in favour of the adoption of such a course. Accordingly, as we announced in our last number, a commission was appointed, consisting of Messrs. G. J. Snelus, J. A. Jones, and J. Lester, "for the purpose of making a complete investigation of the working of Danks's rotary puddling machine, and all the special appliances belonging to it, as mentioned in the paper which that gentleman read before the Iron and Steel Institute at Dudley, August 30th, 1871," and these gentlemen left England for America last week. With a view of testing the applicability of the machine for working English ore products, the following materials have been ordered by the Committee to be sent out with the Commission, to be treated in Mr. Danks's furnace:

10 tons of Cleveland forge pig iron.
10 ,, South Wales ,,
10 ,, South Staffordshire ,,
10 ,, Derbyshire ,,

It will be remembered that this was a question raised during the discussion that followed the reading of Mr. Danks's paper, the principal point being as to the applicability of the ores available in this country for the purposes of fettling the puddling chamber; and to decide this point the Committee have also taken out the following samples:

2 tons of Ilmenite
2 ,, Pottery mine
2 ,, Purple ore
3 ,, Lisbon ore
3 ,, Marbella ore
3 ,, Spanish ore.

However suited the machine may be for American ores and pig iron, it is an essential point that the suitability of our own materials should be sufficiently proved before adopting a machine which, as may be well calculated from a reference to the drawings, which appeared in Engineering last week, would be attended by a not inconsiderable outlay of capital. The main points to which the attention of the Commission are directed are: 1. The general description of the furnace and accessories. 2. The mode of fettling the furnace; full particulars of materials used; quantity of each kind; how long the fettling stands in the furnace; the amount of repairs done to lining between the charges. This should include a considerable number of charges, in order to get a proper average, and full particulars of each should be given. 3. The quantity of fuel used; quantity consumed per ton of puddled bar produced for periods extending over a whole week's work of each furnace under examination. 4. Details of each stage of the process; time occupied in fettling; time in melting iron; time in working before cinder is tapped off, and revolutions of machine at each change of speed; time of working from tapping off cinder to balling up; time in preparing for next charge. 5. Quality of iron produced. Samples of each kind of iron worked should be kept for analysis, and samples of puddled bar produced from each charge containing English materials should also be taken, and carefully marked, so as to admit of easy identification. 6. Particulars of quantity and quality of slag run off from each charge. 7. The weight of iron charged in each heat should be carefully recorded; also particulars of weight of hammer scale, or other materials put in with the iron. Attention is specially directed to the statements in Mr. Danks's paper, that a greater weight of puddled iron is brought out of the furnace than is put in as pig iron. 8. Looking at the number of furnaces at work, it is requested that particulars may be reported as to the percentage that are kept in operation each shift, with the view of affording data for estimating the amount of work to be expected from

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* See Engineering, vol. x., p. 460.

a whole forge fitted up on Danks's system. 9. Particulars as to the number of men employed in connexion with each furnace and with squeezer; class of workmen, whether ordinary ironworkers or mechanics. 10. Royalty paid per ton in America. 11. Particulars as to the number of works where the apparatus is in operation, and number of furnaces at each place; opinions of American practical men on the machine; details of classes of finished iron for which the machine-made puddled iron is used; whether used alone or mixed with scrap or old rails when being converted into finished iron. 12. Particulars as to the production of steel blooms in the rotary furnace. 13. Particulars as to loss on the machine-made iron in the secondary stages of the manufacture. 14. How far the squeezer is an essential part of the system. 15. The heat at which the furnace is worked.

In addition to the above special points of observation, the Commission have been requested to make a detailed daily report during the whole time of their investigations, embracing full particulars of everything connected with the working of the rotary furnaces that come under their notice. The commercial aspects of the matter under inquiry are also directed to their careful attention, and they are requested to make such comparisons, and obtain such facts as will enable them to report upon the commercial bearing of the machine puddling apparatus, and upon the relative cost of puddling by the machines as against the cost of hand puddling. Samples of American pig iron and fettling materials used are to be brought away by the Commissioners, who after completing their investigations are requested to agree upon a joint report, giving the particulars recorded from time to time in appendices under the various headings given above. And, finally, they are requested to make their inquiry a complete record of all facts bearing upon the subject, but their report is to embody the opinions deduced from a careful consideration of those facts.

If these instructions be fully carried out, as we have full confidence they will be, the report of the Commission will be one of very great interest both to the manufacturer and consumer, and we shall hope, at the earliest possible date, to publish it in our columns. If the report be a favourable one, another great stride will have been made in the application of mechanical appliances to the manufacture of iron, the full importance of which it may not, at present, be possible fully to foresee.

ERRATUM.—In the heading of the third paragraph of Notes from the South-West in our last number: for "River" read "Weir."

ENGRAVING BY THE SAND BLAST.—The *Journal of the Franklin Institute* gives the following account of a proposed substitute for the process of wood engraving. A description of Mr. Tilghman's process of cutting hard substances appeared, we may mention, on page 203 of our last volume. Our contemporary says: "The new mechanical agent, the 'jet of sand,' has as yet, we are fully convinced, only exhibited a fraction of its possible applications. The latest adaptation its ingenious inventor has succeeded in developing into practical efficiency, is to a peculiar process of replacing the art of wood cutting. The few experiments conducted in this direction have given such promise of success, that we feel justified in predicting for it a most important rôle in the future of the art it represents. We hope, in our next issue, to be able to present to our readers an engraving produced by the use of the sand-blast, of which we have in our possession some excellent specimens. The process, which we are only at liberty to describe in general terms, consists in bringing upon a suitable matrix a photographic copy of the drawing or engraving which it is desired to reproduce. This is then passed beneath the sand-blast, and the cutting thus obtained. This is finally subjected to the electrotyping process, and any desirable number of copies thus produced. In connexion with the same invention, it may be of interest to mention that it has been successfully applied to the cleaning of brass cuttings in the establishment of William Sellers and Co., Philadelphia, but more especially to the decoration of marbles and other stones for ornamental purposes, at the works of Mr. Struthers. For this purpose, the blocks are protected with an open design of sheet-iron, or of sheet-rubber, and the steam sand jet directed upon them from a convenient distance."

THE GENERAL ASPHALTE COMPANY.—A prospectus has been issued of the "General Asphalte Company" with a capital of 60,000*l.* in 12,000 shares of 5*l.* each. This company has been formed to take over and carry on, on an extended scale, the business of asphalte importers, manufacturers and contractors, of Messrs. Armani and Stodart, 35, Poultry, E.C., including a contract entered into with Mr. Armani, for the exclusive supply to him for thirty years from 1st July, 1870, for the United Kingdom and the British Colonies, of [any quantity of asphalte, whether rock, powder or prepared mastic with a minimum of 600 tons per annum, from the productive mineral rock asphalte quarries at Garde Bois and Lovagny, which form part of the well-known asphaltic basin of Seyssel, Upper Savoy. These quarries are stated to cover 1,575,025 square yards, and they produce an asphalte well adapted for paving and other works. The workshops and steam crushing machines are close to the lines of the Paris, Lyons, and Mediterranean Railways. The consideration for the transfer of the goodwill of the business, including the plant and machinery now on the premises, and the contract for the supply of asphalte before mentioned, and all contracts for the supply and laying down of asphalte entered into by the firm and in hand on the 29th September, 1871, is fixed at 3200 fully paid-up shares. The stock-in-trade to be taken at a valuation to be made in the usual way, and Mr. Armani accepts the appointment of managing director. The firm has been established for the last 23 years and has during that time executed extensive asphalte works, and amongst others the road and paths at Osborne, under the direction of the late Prince Consort; and works at Tattersall's, Aldershot Camp, the Arsenal and Barracks at Woolwich, &c.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—On Wednesday last the pig iron market closed—sellers 61s. 4½d. cash, 61s. 7½d. one month; buyers, a shade less. On Thursday the market was flat, and business was done at a decline of about 8d. per ton; and on Friday there were some fluctuations, the closing prices being 59s. 8d. cash and 61s. one month. The market was flat at the opening on Monday, but it afterwards improved, business was done at 60s. 4d. cash and 60s. 7d. one month, closing sellers at the former price, buyers at the latter. The tone was easier yesterday, and prices were down at 60s. 3d. one month and 59s. 10½d. cash. To-day the market has been somewhat firmer, business done up to 60s. 2d. cash and 60s. 5d. one month, closing buyers at the best prices, sellers 1d. more. Makers' iron still remains firm, the prices for which (with the exception of Glengarnoch, which was raised 1s. last week) are unchanged. Gartsherrie and Coltness No. 1 are quoted at 72s., Summerlee at 69s., Glengarnock at 68s., Calder at 67s., Shotts and Langloan at 66s., and Carnbroe at 65s. The shipments of Scotch pig iron for the week ending 7th October were 16,379 tons; same week last year 16,643 tons; decrease, 264 tons; total since 24th December, 1870, 641,289 tons; and for corresponding period in 1869-70, 491,513 tons, being an increase of 149,776 tons. The total imports of Middlesbrough pig iron into Grangemouth were 62,704 tons up to last Saturday, at same date last year 51,944 tons, increase for 1871, 10,760 tons.

The Clyde Ship Carpenters' Lock-out.—As threatened fully a week ago, the lock-out by the ship carpenters at the lower shipbuilding ports were locked out last Wednesday with the view of bringing the men in the Glasgow, Govan, and Partick districts into subjection. It may be remembered that about 1000 men struck in these districts some seven weeks ago for an advance of wages of 3s. per week. Messrs. Tod and McGregor gave the advance, but with that exception the Glasgow, Partick, and Govan employers stuck out against the demand, and the men left their work. The Greenock, Port-Glasgow, and Renfrew men were offered an advance of 1s. 6d. per week, which they accepted for the time being, and continued at their work. Meantime the strike hands obtained work in such numbers in Dundee, Leith, Newcastle, Hull, and other places that there were not more than 90 or 100 on the strike list a week ago. The extreme measure now resorted to has created a profound feeling of dissatisfaction, but still its adoption is not universal. Messrs. Denny Brothers and the other Dumbarton firms have kept aloof from it, and even upon the other side of the river the lock-out is only partial in some of the yards. As it is, however, the strike and lock-out are most unfortunate, and efforts are about to be made to bring the dispute to an end by some sort of compromise. Mr. Grieve, M.P. for Greenock, has signified his willingness to act as one of the referees, and Mr. Anderson, M.P. for Glasgow, has been communicated with to ascertain if he will act along with Mr. Grieve. A deputation of the Greenock carpenters waited upon the Glasgow carpenters on this subject, and it appears that both bodies are favourable to the gentlemen just named.

Miners' Wages.—Throughout most of the mining districts of Scotland—Lanarkshire, Ayrshire, Renfrewshire, and Fifeshire—the miners have very generally had an advance of 6d. per day in the rate of wages within the last few weeks. In some districts the rate of wages is from 4s. 6d. to 5s. per day. There is a large demand for coals both for home consumption and for exportation, and as stocks are very low in most instances, the advance of wages has been obtained with very little trouble. Only in a few cases has there been a strike, and even then it has been of short duration. In Fifeshire there is an intention to ask another advance of 6d. per day in the course of a month or so. The shipments last week were, foreign 23,871 tons, coastwise, 19,297 tons; total, 43,168 tons; same week last year, 26,685 tons, being an increase of 16,483 tons.

The Burntisland Wet Dock Scheme.—The last application to the Public Works Loan Commissioners for money to construct the wet dock at Burntisland has met with no better reception than those formerly made. At first the amount required (50,000*l.*) was asked at 3½ per cent., which the Commissioners refused, holding out hopes, however, that with good security the sum might be forthcoming, but at a higher rate of interest. The demand has been since twice renewed, the last time backed by influential support, and by the railway company who, on certain concessions being made to them, joined in offering security, which it was believed would bring about a favourable consideration of the scheme. This application having been lodged on the eve of their lordships' vacation, has lain over for two months, and has only now been disposed of. The Commissioners refuse the application, and on terms it would appear which leave no hope of its being renewed with success in the same quarter.

The New Harbour Works at Aberdeen.—The works in connexion with the New South Breakwater, at Aberdeen, are now nearly suspended for the season. The length built during the season has not been nearly what the harbour engineer promised at the beginning of the season to execute. Much time, however, was lost in making preparations. The part constructed was severely tested during the recent storm which prevailed along the east coast. The sea was very high, dashing not only over the breakwater, but over the staging and cranes 50 ft. above the top of the construction, but not a particle of damage was done, the concrete standing firm as a rock. The works at the diversion of the river Dee were not so fortunate. At the seaward end of the new channel an embankment was left of about 20 ft. broad at the top, with a slope of 1 in 3 to keep out the sea water. During the storm the sea burst through this embankment, carrying away the steam pump and spouts used to keep the channel clear of water. The new channel was soon filled with water from one end to the other. Fortunately, the works are so far advanced that no further damage is likely to be done, the pitching of the slopes having been completed. Indeed, the river was to have been let into the new bed in January. Although this accident will occasion about three weeks' delay, it is not expected that the opening of the cut will be delayed. The damage done is estimated at about 500*l.*, it being expected that all the plant will be recovered.

Mr. J. F. Bateman on the Dundee Water Scheme.—Mr. Bateman has just supplied the Dundee Water Commissioners with a letter in reference to the cost of the scheme, whereby it is intended to supplement the water supply of Dundee by resorting to Lintrathen. He proposes to bring in a first instalment of 8,500,000 gallons at a cost of 172,940*l.*, and he calculates that this addition to the present means of supply would suffice, with the increase of the population, for eighteen years from the present time. A further outlay of 76,330*l.* would be required for bringing the second instalment of 6,500,000 gallons.

Quarterly Report on the Glasgow Water Works.—At their ordinary meeting on Monday last, the Corporation Water Committee had the engineers' quarterly report under consideration. It stated that on the 30th ultimo there were 102 days' supply of water in the lochs, and as the summer had been a wet one in that district, there has seldom been less than this quantity in store. On the same date there was 19 days' supply for the city in Mugdock Reservoir. The Gorbals reservoirs only contain 43 days' water, or 13 days less than at the corresponding date last year, which is partly accounted for by there having been a greater quantity of water supplied to the town from these works this year than last. The quantity of water sent into the city and district during July, August, and September last, averaged 28,150,000 gallons a day from Loch Katrine works, and 3,910,000 from the Gorbals works—in all, 32,060,000 gallons a day; being an increase of 2,710,000 gallons a day over the corresponding three months of 1870.

Extension of Harbour Works at Port-Glasgow.—It has been resolved by the Port-Glasgow harbour trustees to increase the harbour accommodation by extending the dry dock 50 ft. further to seaward, with the view of providing facilities for an extensive firm of sugar merchants to bring their vessels and cargoes to the port.

Gunpowder Blasting at Furnace Quarries.—Mr. Sim, the lessee of the extensive granite quarries on Loch Etive, near the village of Bonawe, in the land of Lorne, has just had another of his monster blasts with gunpowder. For more than a year past the process of boring the rock had been going on, and on Monday week the inmost chamber having been completed, four tons of gunpowder, costing in all 160*l.*, were safely deposited therein, at a point 50 ft. within the rock face. The passage having been thereafter duly "stemmed," the blast was fired on Thursday at 3 p.m. The final stage in the process presented little to the mere sight. There was a muffled roar, the hill front seemed to heave slightly, and then subside bodily into the floor of the quarry; not in one solid mass, however, but in pieces ready for being worked to the proper size. Many thousand tons of excellent material are thus disrupted at one stroke, which will give occupation to the dressers for weeks to come. By-and-bye the results of their labours will be conveyed by lighters to Glasgow and elsewhere, to be used in paving the streets, and for other purposes.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a good attendance on 'Change at Middlesbrough. The market was firm at last week's prices, and a good deal of business was done. Considerable interest was evinced in the Cleveland Ironmasters' Association returns for September. These show that, out of a total of 131 blast furnaces, there are 126 blowing. The total production during the month amounted to 152,857 tons, an increase of 9325 tons compared with the same month last year. Makers' stocks amount only to 90,127 tons, and the Middlesbrough Warrant Stores have been decreased to 5125 tons. Shipments at Middlesbrough are very active, and the local consumption of pig iron is heavier than ever.

The Finished Iron Trade.—Rails are still in request, but as the navigation season is closing, the shipments are not so heavy as they have been for some weeks past. Plates and angles are made in great abundance, but the demand is so exceedingly heavy that the supply is unequal to the requirements of the iron shipbuilding trade, which is in such a prosperous condition. Bar iron is in good demand, and sheets, hoops, rods, and billets meet with a ready market.

The Ironworkers and Mr. Hughes's Award.—Last week we called attention to the fact that many of the ironworkers in the North of England seemed to pay little regard to the regulations of the Board of Arbitration, and we published the resolutions which had been passed at a meeting at Stockton, showing that although the ironworkers had through the Board submitted the wages question to Mr. Hughes, M.P., they would not be satisfied with anything short of the additional 5 per cent. on the present rate of wages. Since then another meeting of ironworkers has been held at Darlington, and they have expressed themselves in the same way as their Stockton fellow-workers. We never hesitate to advocate the views and claims of the men when they are fair, but on this matter we must remind them that they having submitted the wages question to Mr. Hughes, M.P., it is unfair to attempt to put pressure upon that gentleman by holding meetings and demanding higher wages. If that is the course they intend to adopt what is the use of arbitration?

The Nine Hours' Movement.—After a suicidal fight lasting twenty weeks the strike in the engineering trade at Newcastle-on-Tyne has ended. Our suggestion at the beginning of the struggle, it will be remembered, was to concede the nine hours and pay the men by the hour. After all the trouble,

expense, misery, and irreparable injury to the trade this is practically what has been done. Mr. Mundella having failed to bring about a settlement of the strike last week it was feared, after the publication of Sir William Armstrong's letter, that the struggle was beginning again. While this apprehension was depressing Tyneside, two gentlemen, whose action will long be remembered, succeeded in settling the question in an amicable manner. On Thursday, the Town Clerk of Newcastle (Mr. Philipson) called upon Mr. Joseph Cowen, jun., the proprietor of the *Newcastle Daily Chronicle*, and after a conversation those two gentlemen, without consulting either party, agreed that the following clauses might settle the dispute: "Suppose the employers were to concede the fifty-four hours per week, the men would agree to work overtime when and to the extent required by the employers." "The wages, both as to ordinary wages and as to overtime, to remain the same in the different factories as existed prior to the strike." "The wages to be reckoned by the hour and quarter hour, and paid weekly at 12.15 p.m. on Saturday." "The agreement to be for twelve months, with power to either party to determine it at the end of six months, by giving one month's previous notice." "The men to go to work on the arrangement now existing in the shops (57 hours), and the new terms (54 hours) to take date from January 1, 1872." Mr. Philipson submitted those clauses to Sir William Armstrong and the employers, and Mr. Cowen laid them before the Nine Hours League and the men, and each party having accepted them, the strike was ended. The details were speedily arranged, and already several of the men have resumed work. To-morrow (Thursday) is the day fixed for the bulk of the men resuming their places at the various factories. At Middlesbrough and other places steps are being taken for obtaining the nine hours' system.

The Mines.—All the mines throughout Cleveland are working steadily. In South Durham the collieries and coke ovens are kept going to their utmost to meet the great and growing requirements of the iron-making district of Teesside, where the consumption of fuel is so enormous.

NOTES FROM THE SOUTH-WEST.

Llanelly Breakwater.—At the monthly meeting of the Llanelly Harbour Commissioners on Friday, the harbour master reported as follows as to the repair of the breakwater:—"Since the last meeting, the rails have been laid so that the ballast wagons can be tipped a long way down by the side of the breakwater. I think that with what we have at command and a few truck loads of slag, when required, it will be tolerably secured. The inspector of the South Wales Railway (Mr. Lean) accompanied by Lewis (Stradey's surveyor) and myself, examined the Stradey and Pool streams both inside the railway and outside. Mr. Lean agrees with me that when those two streams are diverted and carried inside the embankment to Llanelly, it will be the best thing that can be done for the improvement of the channels from Llanelly to Pembrey, which are now continually out of gear."

State of Trade at Newport.—The tin-plate makers have resolved to maintain the prices of tin plates at the previous standard; and in spite of advancing prices in iron, enhanced quotations for pig, and the smallness of the stocks in the makers' hands, the prudence of the course adopted is not disputed. The price of hematite pig is still advancing; about 87s. 6d. for No. 3 has been the current rate. Considerable sales have been effected and a feeling of cheerfulness has pervaded the market.

State of Trade at Merthyr Tydfil.—The iron works in the neighbourhood of Merthyr Tydfil have been well occupied of late, some with Canadian and others with South American orders. The demand for coal continues large.

Monmouthshire Railway.—The Monmouthshire Railway Company has a suspense relaying account. It has, however, been reduced to 22,432*l.*

Swansea Harbour.—At the monthly meeting of the Swansea Harbour Trust on Monday, it was stated that the revenue of the harbour in September was 3760*l.*, as compared with 3440*l.* in September, 1870, showing an increase, last month, of 319*l.*

Newport Dry Dock Company.—In spite of several slips occasioned by late heavy rains, the Newport new dry dock is progressing satisfactorily, and the contractor, it is understood, is sanguine of completing the works by January. The company has resolved to increase the length of the new dock by about 25 ft., thus making it upwards of 300 ft. in length. The company has taken from Mr. Herbert, of Llanarth, a long lease of the extensive wharf and premises lately occupied by Mr. Martin Morrison, at Jack's Pill, adjoining the dry dock; and the directors contemplate laying down a gridiron next year in Jack's Pill.

Customs at Bristol.—The amount of customs duties collected at the Port of Bristol in September was 75,516*l.*

State of Trade at Cardiff.—The supply of steam coal is increasing at Cardiff, but it is not yet fully equal to the requirements of the trade. Good prices are, however, obtained, and what is lost in quantity is more than made up in most cases by the unusually high prices realised. The total quantity of coal exported from Cardiff in September to foreign ports was 190,263 tons; the shipments coastwise were 73,776 tons. The total exports of patent fuel during the month were—to foreign ports 5674 tons; coastwise 625 tons. The exports of coke were 1294 tons and 114 tons respectively. The total quantity of iron exported from Cardiff in September was 21,309 tons; of this total 1440 tons went to Galveston, 1595 tons to Mollendo, 1037 tons to Mobile Bay, 1538 tons to Montreal, 2850 tons to New Orleans, 6259 tons to New York, &c.

Taff Vale Railway.—The traffic of the Taff Vale Railway, adversely affected by the great strike among the steam coal colliers of South Wales, has not quite regained its former level. In the week ending September 30, the receipts were 7045*l.* against 7393*l.* in the corresponding week of 1870. The aggregate receipts of the quarter ending September 30, were 70,220*l.* against 91,706*l.* in the corresponding three months of 1870.

South Wales and West of England Coal and Metal Markets.—A market was held at Swansea on Saturday. The attendance was small, but the reports received from the leading merchants were satisfactory. A considerable trade in pig has been done of late and prices are decidedly firmer. Makers are very full of orders, and buyers who have not made their arrangements, must pay full prices for prompt delivery.

Testimonial to a Retiring Partner.—On Thursday in last week a testimonial in the form of an address beautifully framed was presented to Mr. Morgan Joseph, of Cardiff, upon his retirement from the active management of the Ocean Steam Collieries. The address observed:—"Your management of these now extensive collieries has extended over a period of six years. It is coeval with the Ocean Steam Collieries themselves. During that time one of the largest, if not the largest, steam coal colliery in Wales has been established, and has been for five years sending coal to market. . . . . Fifteen hundred officers and workmen with their families depend upon the works for their subsistence directly, besides indirectly such a neighbourhood as becomes necessary to attend to the wants of a mining community."

FOREIGN AND COLONIAL NOTES.

Roumelian Railways.—The contractors for these lines are showing increased activity as winter approaches. It is hoped that by the close of the year 250 miles will be in working order on the different sections of the system. The traffic is already considerable on the metropolitan section open from the Seven Towers to Kutchuktchekmedjè, and the company has increased its rolling stock of late.

Indian Coal.—Coal has really been found in the Nizam's dominions. It has been brought to light in the rocky bed of a forest stream flowing from the border of Dewarlah towards Goondral. The coal is reported to crop out, and lie very near the surface, and on the banks of the river, in large masses or heaps.

Belgian Rails.—The exports of rails from Belgium in the first six months of this year amounted to only 38,486 tons, as compared with 66,833 tons in the corresponding period of 1870, showing the large falling off of 28,397 tons. In the total of 38,486 tons, the Zollverein appears as a consumer of 9289 tons, while the Low Countries took 1170 tons, Austria, 1306 tons, Turkey, 500 tons, and Russia, 580 tons.

M'Gill (Canada) University.—The board of governors of this university have appointed Mr. G. F. Armstrong Professor of Civil Engineering. Mr. Armstrong, who graduated at Cambridge, is a member of the Society of Arts, and also an associate of the Institution of Civil Engineers.

Progress in Russia.—We may note the opening of the western half of the Poti and Tiflis Railway and the completion of surveys which have been in progress during the whole summer upon the Lower Koaban. Upon this river, which drains the northern slope of the Caucasus from Stavropol to Taman, it is proposed by the Russian Company of Trade and Navigation to establish a regular line of steamers; and they have accordingly organised a survey in order to ascertain which of the two mouths of the Koaban—that opening upon the Sea of Azof or that opening upon the Black Sea—is most suitable for the purpose. The opening of the Poltava and Kharkov Railway connecting Kharkov with the Dnieper and with Odessa has produced a marked influence upon the whole district. The influx of visitors to the spa of Sorotchintzi has been more than double that of last year; and the trade of Kharkov, Mirgorod, and other commercial centres is improving.

A New American Steamship Line.—The project for the establishment of a direct line of steamers from Philadelphia to Europe is stated to be making good progress. The contractors for building the vessels to be employed on the line are pressing on their work with energy.

The Russian Army and Navy.—It is officially announced that the Russian army is now completely equipped with the new Russian breechloading rifles known as the Kronk rifle. The sum allotted in next year's Russian budget for the marine department of the Black Sea will amount, it is stated, to 4,600,000 roubles (736,000*l.*). This is a larger sum than has been allowed in preceding years, but still it is not sufficient *per se* to create a formidable Black Sea fleet. It is clear, however, that Russia is availing herself of the clause in the treaty of London, by which she is empowered to maintain dockyards and build ships in the ports of the Black Sea.

Thomason Engineering College.—Lieutenant Graves, R.A., has passed out at the head of the list of students this year, and has carried off the prize for civil engineering. The Cautley gold medal for surveying has fallen to Mr. E. Foster, son of Colonel Foster, of Her Majesty's 12th Regiment.

Singular End of a Belgian Strike.—Some time since the mechanics in the employ of MM. Enthoven and Deville, of Brussels, succeeded in carrying a reduction in their hours of labour to ten per day. They found, however, that their wages declined from 50s. to 35s. per week, and they have accordingly appealed to their employers to restore the old working hours. To this course MM. Enthoven and Deville have assented.

Metallurgy in New South Wales.—It is stated that the Fitzroy Iron Works at Nattai, near Berrima, have been purchased by an English firm. It is also stated that working operations will be carried on with vigour.

Russian Railways.—At the commencement of July, 1871, the extent of railway conceded in Russia was 14,308 versts of which 11,032 versts were in working order and 3276 versts in course of construction. The mileage conceded is divided among forty different companies, and to remedy the inconveniences resulting from such multiplicity of surveys a conference composed of delegates from the various companies has just been held at St. Petersburg.

New Orleans.—It is seriously declared that New Orleans, never too high, is slowly sinking. The settlement varies from 3 ft. to 7 ft.

Belgian Coal.—In the first six months of this year the exports of coal from Belgium were reduced—by the war of course—to 1,353,946 tons as compared with 1,844,147 tons in the corresponding period of 1870.

Canadian Pacific Railway.—The advices received as to the progress of the surveys for the Canadian Pacific Railway are favourable. A great deal of work has been accomplished.

Yan Yean Waterworks.—These works have proved highly remunerative to the Victorian Government. The amount of revenue collected in 1870 was 100,675*l.*, and after payment of all the expenses of the year the Government was enabled to carry 71,237*l.* to the credit of the general revenue of the colony.

A Ferry-Boat for the Grand Trunk.—Sections of an iron ferry-boat, built on the Clyde for the Grand Trunk Railway of Canada, have arrived out at Fort Erie where they are being put together. The boat, when completed, will take the place of the International, the present ferry-boat, and will continue at work until the completion of the International bridge, when she will be used between Sarina and Port Huron.

Reduction of Bunker Hill.—Commissioners upon the reduction of Bunker Hill, have made a report to the city government of Charlestown. The total cost of the undertaking is estimated at 5,271,771 dols. From this should be deducted the value of Mill Pond lands and Mystic river flats to be filled in 1,726,178 dols., which will leave the net cost 1,545,644 dols. The area of the Mill Pond lands to be filled in is 1,549,000 square feet, and the area of flats in Mystic river to be filled in is 2,851,187 square feet. The number of buildings in the district which will require to be lowered is 473. The contemplated improvement will add about 150 acres to the territorial limits of Charlestown.

Indian Railways.—The Bombay, Baroda, and Central India Railway Company have so far surmounted its monsoon difficulties that through communication has been restored all along the line. As regards the Punjab, Sinde, and Delhi Railway, it may be observed that in order to restore communication between Sahrunpore and Sirhind, a temporary viaduct is to be constructed over the Guggur, as nothing can be done towards building a permanent bridge until next season. As regards the Beas, no bridge over that stream need be expected for two years, as girders and all other iron material will be required from England.

Toronto, Grey, and Bruce Railway.—This line is expected to be opened as far as Mount Forest by December 1. The directors have entered into an agreement with the county of Grey to construct the railway direct from Orangeville to Owen Sound for a bonus of 300,000 dols. The "location" has been completed, and contracts have been awarded to Mr. T. Shanly for the first and second sections, and to Messrs. Mackenzie and Co. for the third section.

Barnes's Boiler Coating.—We believe that the boiler composition lately introduced by Messrs. Barnes and Son, of Blackburn-road, Accrington, is being extensively applied with considerable success. The advantages which appear to be fairly claimed for this composition are that it is cheap, easily applied, and extremely efficacious in preventing loss of heat, with a resulting economy of fuel and increased comfort in the boiler house.

Old Silver Mines in Scotland.—In exploring the old workings near Bathgate, an old hammer has been found in one of the silver mines. The handle is round, 2 in. in diameter, and about 14 in. in length. The head is of iron, and anchor-shaped. The main pit, or entrance to the whole series of pits and mines, is about 9 ft. by 6 ft. in width, and 21 fathoms deep. The walls are of solid limestone rock, finely chiselled, and bearing innumerable initials of individuals, among which is "C. H., 1698," and beneath it a coat of arms. From the bottom of this pit, shafts run in all directions; and at the termination of one of these, another pit, several fathoms in depth, has been discovered. At the bottom of this second pit other mines have been found, and at the extreme end of one of these there is found a third pit, which has not been thoroughly explored on account of the quantity of standing water contained in it. On the walls of this last pit the year "1498" is carved. It is surmised that the workmen had drawn the water in bucketfuls from the lowest pit, conducted it to the bottom of the second pit, and, by the same means, raised it from the second to the third pit, whence it ran along a main level, and discharged itself into a stream in the neighbourhood, where the metals were crushed and washed. The various veins have been cleanly wrought out, and one of them was no less than 30 ft. in height. The rubbish had been neatly repacked into the veins to save the labour of carrying it to the pit's mouth. The workmen had descended the first pit by means of a windlass, and the remains of large beams are still visible there; but it would appear that they had descended and ascended the other pits by niches cut out of the solid rock. It is thought by experienced workmen that the only way these mediæval miners could have taken the water from the mines must have been by means of a level cut through the Bathgate hills, about a mile and a half in length; and an investigation is to be made to ascertain the correctness of this supposition. Besides silver and lead, platinum has been found in abundance, and the mines are now being worked energetically.—*Scotsman.*

BAUSCHINGER'S INDICATOR EXPERIMENTS ON LOCOMOTIVES.

(*Continued from page* 199.)

3. The Absolute Performance of Steam and Fuel.

The relative efficiency, or economical value, of a steam engine as a power-producer is proportionate to the amount of fuel required while performing a certain duty, and this amount is dependent, in its turn, upon three elements: 1. The evaporative efficiency of the boiler and of the fuel employed, as expressed by the quantity of water evaporated per pound of fuel consumed. 2. The absolute performance of the steam in the cylinders, that is to say, the steam or water consumed per indicated horse power per hour. 3. The useful effect given off by the engine as compared with the absolute or total performance of the steam. The consumption of fuel per effective horse power per hour can easily be ascertained by measuring, on the one hand, the quantity of fuel burnt, and by employing, on the other hand, an appropriate dynamometer, recording the useful work developed during a certain period; while, in order to define accurately the other elements, above enumerated, the water evaporated, together with the absolute performance of the steam, as shown by the steam diagrams, should be measured at the same time.

Although the experiments under notice are not specially suited to investigate fully all these points, yet the mode of conducting the experiments, as explained by us on page 1 of the present volume, was such as to afford, nevertheless, some valuable information as regards the absolute duty performed by the steam during each trial run, the evaporative capacity of the boilers, and the consumption of water and fuel per indicated horse power per hour. It is to be regretted, however, that an efficient traction dynamometer was not employed by the experimenters, so that the useful effect given out by each engine might have been obtained.

For the special purpose of comparing the relative values of two different systems of valve motions, and in order to ascertain the effect of various modifications of one and the same system of steam distribution, it is an essential condition that the properties of the engines as steam users should be treated as distinct from those of the various boilers as steam producers; hence the quantity of water used per indicated horse power per hour is the real coefficient of efficiency, as being independent of the evaporative capacity of the boiler, and of the internal resistances of the engine proper. On the other hand, it should be remembered that the coefficient expressing the quantity of water used is influenced, to a greater or lesser amount, by the water which is carried along in a globular state with the steam, and in the case of locomotive engines, especially, this quantity of water thus mechanically carried through with the steam bears a considerable proportion of the whole amount of water consumed. The loss occasioned by moist steam in this manner was not accurately measured by Professor Bauschinger, but every precaution was taken (by observing the normal water level and boiler pressure), to obtain a supply of steam in an equally dry state during the various runs. If this equality of condition was really obtained, the records of the quantities of water used per indicated horse power per hour, will serve the purpose of comparing the efficiency of the different valve motions much better than the corresponding amount of fuel burnt, which latter element depends, as we have stated, both upon the capabilities of the boilers as steam producers and upon the evaporative efficiency of the fuel consumed.

The limited space of necessity allotted for this series of articles prevents us from reproducing, *in extenso*, the detailed observations made by the experimenters with each engine and during each succeeding period of the trial runs. We publish, however, on page 249, a Table (No. VII.) recording the general results obtained by Professor Bauschinger, and Locomotive Superintendent Zorn, of Augsburg. This Table contains 30 columns, which have been worked out in the following manner: The first column refers to the different classes of engines experimented upon, and of which we have given the leading dimensions in Table No. I. page 1 of the present volume; columns 2 and 3 give the lengths of the various trips and the total rise or fall in feet between the different stations, while the times, gross and net, occupied on trip, are given in the next two columns. The following columns, 6, 7, and 8, have reference to the nature of the experimental trains and the state of the weather. Columns 9 to 13 contain data as regards the mean velocity of the different engines, the boiler pressure, and degree of expansion; the total amount of work done on the various trips is given in columns 14 and 15, the former containing the total number of foot-pounds of work developed during trial as computed in the following way: In the first place, the mean effective cylinder pressure, shown by the indicator, under a certain boiler pressure, was reduced to the average pressure indicated by the boiler steam gauge during a certain period, the entire trip being subdivided into a number of such periods, according to the position of the regulator, the reversing lever, and blast pipe orifice. For instance, supposing the mean effective cylinder pressure to be 65 lb., the corresponding boiler pressure 100 lb., and the average boiler pressure for the period 114 lb., then

$$\text{reduced effective pressure} = \frac{65 \times 114}{100} = 74 \text{ lb.},$$

this figure, multiplied by the number of revolutions made by the driving wheel during the period gives the corresponding amount of work done, and the results thus obtained for all the periods of the whole trip, added together and then multiplied by the constant factor 4 × piston area × stroke represent the total number of foot-pounds of work developed during the entire run. The figures in column 15, which have been derived from the preceding column and from the fifth, express the performance of the engines in horse powers of 33,000 lb. per minute. Column 16 refers to the nature and to the quality of the fuel consumed, but we have no very precise information as regards the evaporative efficiency of the different fuels used. The weight of the peat per cubic foot is given, however; the coals employed were of the average quality as found in Saxony. Columns 17 to 20 give figures relating to fuel and water consumption; the total quantity of fuel burnt, as given in column 17, refers, in some cases, to a double journey, as at some of the stations the fuel could not be conveniently weighed, and in the case of engine (D) this was entirely neglected. The principal results for comparison of engine efficiency are given in columns 18 and 20, viz., the consumption of fuel and water per indicated horse power per hour. Columns 21 to 25 contain data which will find their explanation in our next article, treating especially on water and steam consumption. In the next four columns, 26 to 29, we have given the consumption of fuel and water both per square foot of fire-grate area per hour and per square foot of heating surface per hour. Finally, column 30 of the Table shows the quantity of water evaporated per pound of fuel consumed.

Referring to the Table, it will be noticed that the quantity of water used per indicated horse power per hour varies greatly; in fact, a comparison of the figures in column 20 with those in column 15 will show that the steam is being more efficiently utilised as the amount of work developed by the engine increases. This may at first sight appear difficult to explain, but it should be remembered that in most cases where engines are employed on work demanding a comparatively small exertion of tractive power, steam is cut off short; the cylinders are, therefore, cooler and the condensation of steam will consequently be greater, particularly in the case of unjacketted outside cylinders. If we take, as an example, the third and fourth trip performed with engine A, we shall find in column 15 that the duty performed was equal to 244 and 140 horse powers respectively; the water used was, in the former case, 27.94 lb. per indicated horse power per hour, and in the latter case 35.31 lb., while the quantity of fuel burnt per indicated horse power per hour, as recorded in column 18, was about the same on both trips. This marked discrepancy between the fuel burnt on the one hand, and the water evaporated on the other hand, is owing to the varying evaporative capacity of the boiler on the two runs; thus when the engine was on the fourth run or on the down journey the consumption of fuel per square foot of heating surface per hour was scarcely one-half of that consumed on the third run or on the up journey, and the water evapprated per pound of fuel burnt was consequently much more in the former case; in other words, while the evaporative capacity of the boiler was more favourable on the down journey, the performance of the steam in the cylinders was impaired in almost the same proportion, but both are compensated in the consumption of fuel per horse power per hour. This consideration confirms our former statement, namely, that for the purpose of rating the relative efficiency of an engine, a distinction should be drawn between the performance of the steam in the cylinders and the capacity of the boiler as a steam producer.

A further comparison of the figures contained in column 20 for the various engines will establish the interesting fact, that the water used per indicated horse power per hour was decidedly less in the engines fitted with the ordinary shifting link motion, than in those engines with the Meyer double valve gear. This result was to be anticipated from our investigation in a preceding article, treating on the form of the indicator curves; nor will it be a matter of surprise that engines A and B, fitted with Allen's or Trick's double admission valve, should show a better performance of the steam in the cylinders than the other engines supplied with the usual slide valve.

(*To be continued.*)

LABUAN COAL TRIALS.

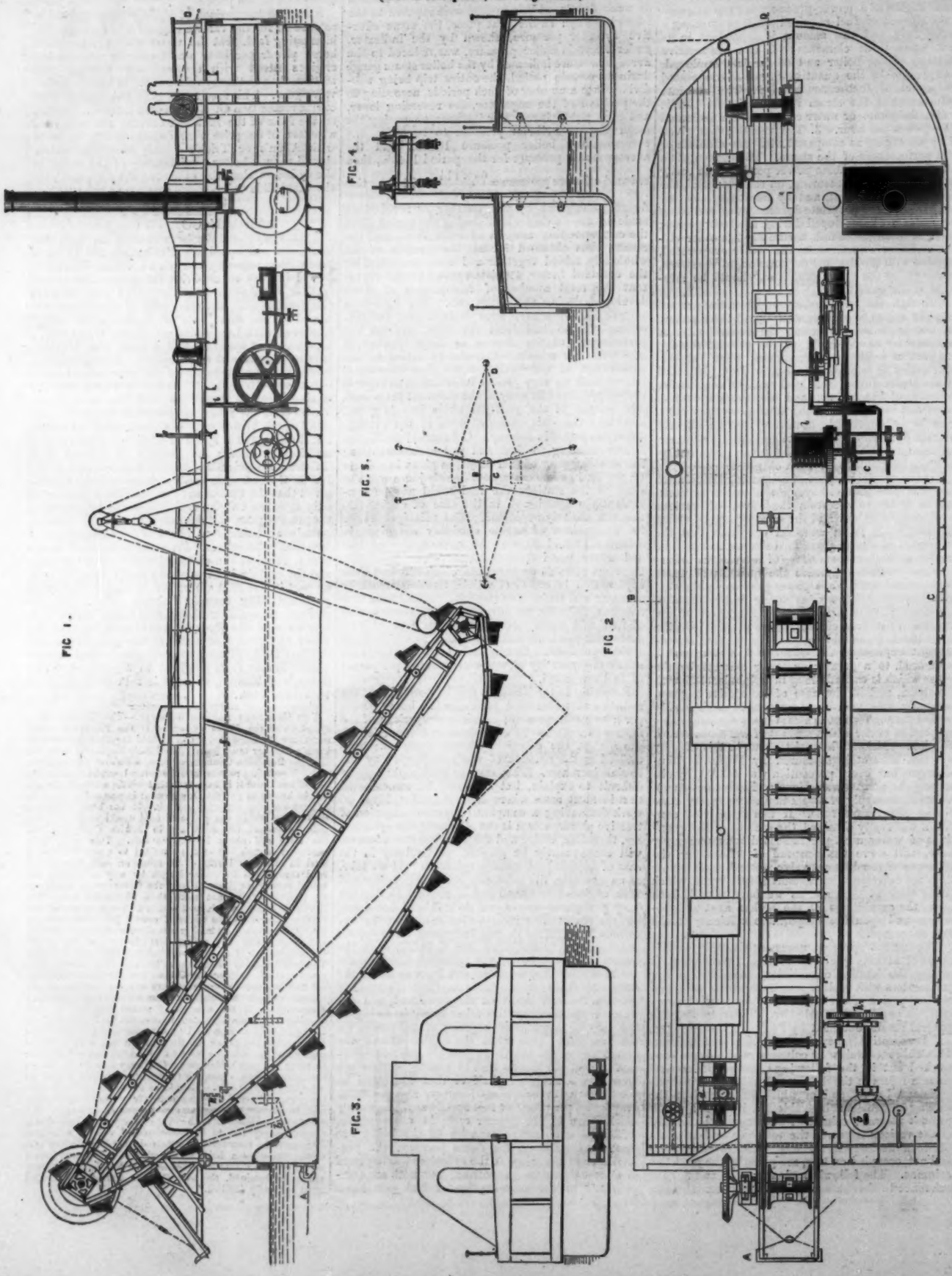
Trials have recently been carried on with Labuan coal on board the Peninsular and Oriental Steam Navigation Company's s.s. China, the results of which prove conclusively the great value of that fuel for steam purposes. Compared with English (Newcastle) coal, the same rate of speed was obtained for the same rate of consumption, whilst compared with Lancashire and North Wales coal, a higher rate of speed by half a knot was obtained for the same rate of consumption. Compared with South Wales coal, to obtain the same rate of speed —8 knots—10 per cent. less fuel was used, and by mixing in equal quantities with the small South Wales coal, the 8-knot speed was maintained. The small South Wales coal was then tried by itself, but it only gave a speed of 6 knots. These highly satisfactory results are entirely in accord with elaborate investigations undertaken by order of the Italian Government, and which led to orders being given that the Italian navy in the China Sea should only consume Labuan coal. Since the beginning of the present year, the Spanish mail steamer calls regularly at Labuan on her way from Singapore to Manilla. The moment the vessel is fastened to the wharf, convicts run on board with baskets of coal, and the captain has frequently stated that there is no part in the East where he is now coaled with greater facility than in Labuan. There are 200 millions of tons of workable coal in the island, midway between the great centres of commerce in the East; and good coal is sold at the wharf in Victoria harbour for 5 dollars a ton, whereas coal of inferior quality is sent from England to Singapore, Hong Kong, and Manilla, where it is sold at from 10 to 14 dollars a ton.

The Canadian Pacific Railway.—The Toronto correspondent of the *Times* writes: "If the Provinces which constitute the Dominion are to be held together, a Canadian Pacific Railway must be built, and, fully impressed with this idea, the Dominion Government have set about the gigantic task. Surveying parties have for several weeks been on the line of road, and it is expected that within a month enough will be known to put the Government in possession of rough estimates of the cost of the work. It has been estimated that the length of the proposed road would be about 2500 miles, of which 600 miles are in British Columbia, and the total cost about 100,000,000 dols. This sum looks enormous enough, but as it is intended to grant 20 miles of land in alternate blocks of 20 miles on each side of the road throughout its entire length by way of subsidy the actual money requirement from the Government would, in all probability, be not more than 35,000,000 dols. The Northern Pacific, which runs within a short distance of our southern boundary line where it crosses Red River, is being built by a company on land grants alone without any subsidy, and through a country a great deal like our own. A powerful combination of American capitalists (including, it is said, Vanderbilt and Jay Cooke) and railroad men have already proposed to the Government at Ottawa to undertake to construct the line, but the Government have not yet decided on any scheme, nor are they likely to do so without first consulting Parliament. If the amount of money required be only 35 millions, Canada will obtain a railway to the Pacific at a cost less by 26 millions than the United States paid for their Union Pacific road. The gauge, it is thought, will be 4 ft. 8½ in. There need be no doubt of the ability of the American combination to carry out any undertaking they may engage in, for its members possess, according to report, an united capital of some 200,000,000 dols. They have already built one Pacific Railway, and could at once transfer from the Union Pacific, now in course of construction, thousands of hands. An addition of 35,000,000 to the debt of the young Dominion is a contingency not to be contemplated without a serious feeling of the responsibility involved; but it is obvious that if the union with British Columbia is to be more than a name, or even if that Province and the Red River Territory are to be retained, the obligation to construct this road must be rigidly fulfilled."

DREDGING MACHINE FOR THE RIVER ELBE.

CONSTRUCTED BY MM. REIHERSTEIGER AND ENGINED BY MESSRS. SCHMILINSKI BROTHERS, HAMBURG.

(*For Description, see Page* 248.)



DETAILS OF DREDGING MACHINE FOR THE RIVER ELBE.

CONSTRUCTED BY MM. REIHERSTEIGER AND ENGINED BY MESSRS. SCHMILINSKI BROTHERS, HAMBURG.

(*For Description, see Page* 248.)

FIG. 2

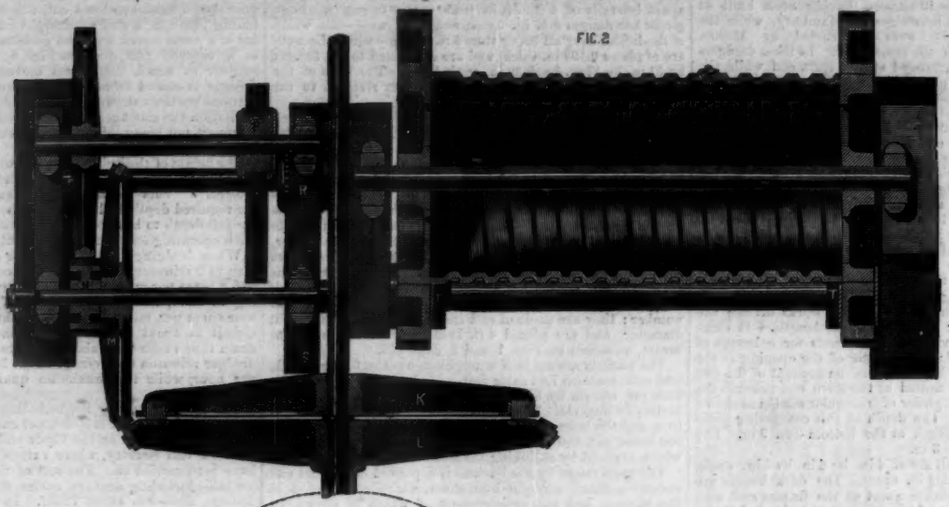


FIG. 1.

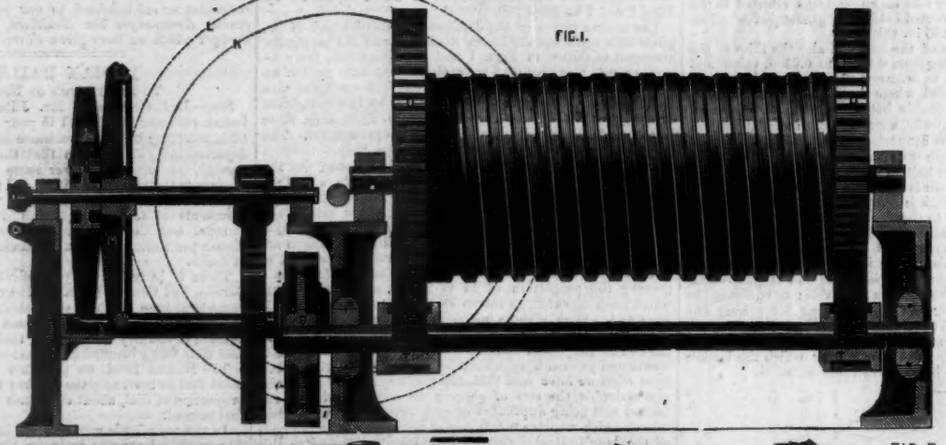


FIG. 4

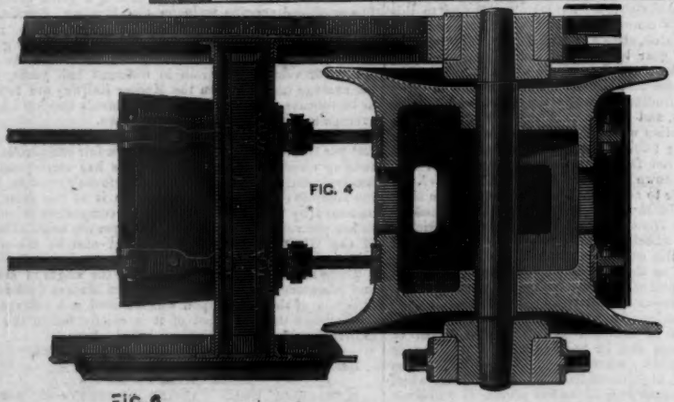


FIG. 5

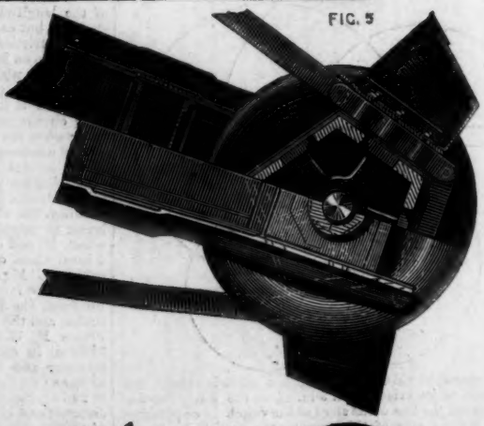


FIG. 6

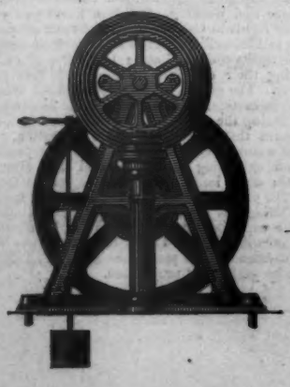


FIG. 7

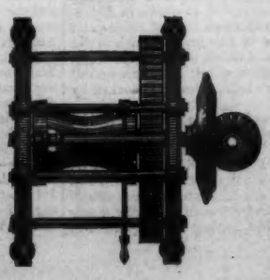


FIG. 8

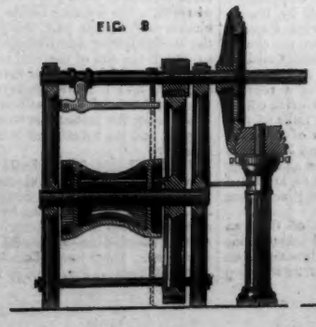
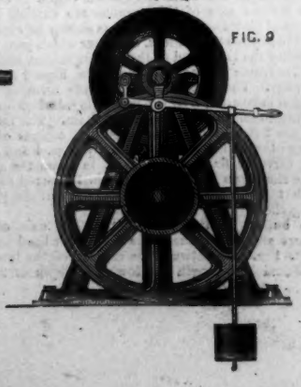


FIG. 9



DREDGING MACHINE FOR THE RIVER ELBE.

We publish on pages 246 and 247, engravings showing the construction of a class of steam dredgers constructed at Hamburg for service on the River Elbe, the hull of the particular machine illustrated having been built at the works of MM. Reihersteiger, of Hamburg, while the engines and machinery were constructed by Messrs. Schmilinski Brothers, of the same place. In these dredgers the bucket ladder is arranged at the stern end while the engines and boilers are placed in the fore part of the vessel so as to form a counterpoise. This arrangement, which was originated, and which has in numerous instances been adopted, by makers in this country enables a very direct delivery of the spoil to be effected, and reduces the height to which the spoil has to be raised by the buckets as compared with the arrangement in which side delivery is resorted to.

The hull of the dredger we illustrate is of iron and has vertical sides and a flat bottom, while it is square ended at the stern and is formed to a semi-circular shape at the bow. Its length is 98 ft. 5 in., its breadth 24 ft. 7 in., its depth 9 ft. 10 in., and the draught of water 4 ft. 1 in. The dredging apparatus consists of a single ladder and chain of buckets delivering the spoil at the stern, as we have already stated, and capable of operating in 28 ft. depth of water.

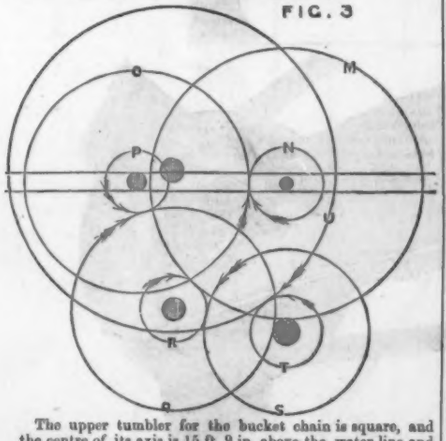
The well in which the bucket ladder works divides the hull into two parts for a portion of its length. It commences at the stern and extends forwards for a length of 58 ft. at the deck level; the length of the opening at the bottom, however, being but 54 ft. 3 in. on account of the two sides of the well being united at the stern end towards the bottom by a kind of box girder of triangular section as shown in Fig. 1 on page 246. The depth of this connecting piece is 5 ft. 5 in. and its length at the bottom 3 ft. 9 in. The width of the well is 5 ft. 3 in.

The frames of the hull are of 4 in. by 4 in. by ½ in. angle iron and are spaced 23½ in. apart. The deck beams are placed at the same distance apart as the frames and consist of 3½ in. by 3½ in. by 0.39 in. angle irons rivetted to the frames and further connected to them by gusset pieces 15½ in. long on the sides and 0.35 in. thick.

The bottom and sides of the hull and also the sides of the well are of plates varying from 0.47 in. to 0.35 in. thick, and the rivets are 0.59 in. in diameter placed at 2.36 in. pitch. The fore part of the vessel, where the engines and boilers are placed, is built with a double bottom so as to afford a firm foundation. The distance between the false and real bottoms is 13¾ in. and the two are connected by vertical plates 0.35 in. thick rivetted to the main frames and to corresponding angle irons rivetted to the false bottom as shown in Fig. 1, page 246. At the water line the hull is surrounded by a wooden fender 6 in. thick, and the deck is composed of Quebec pine, the planks being secured to the deck beams by square-headed screws screwed in from below.

Commencing at the fore part, the dredger contains the following compartments: First, in the round of the bows a cabin for the engineers, next the boiler and engine rooms, the latter having coal bunkers on each side; next comes the compartment containing the hoisting gear for raising the bucket ladder; while at the sides of the well are cabins for the captain and crew respectively, and at the stern end are compartments containing the gearing by which the bucket chain is driven, as will be explained presently.

FIG. 3



The upper tumbler for the bucket chain is square, and the centre of its axis is 15 ft. 9 in. above the water line and 2 ft. beyond the line of the stern of the vessel. The plummer blocks for the axis of this tumbler are carried by frames built up of plates and angle irons as shown in Figs. 1 and 3, page 246; while the pulleys, &c., over which pass the chains for raising the lower end of the bucket ladder, are carried by a similar frame of the form shown in Figs. 1 and 4 on the same page. The lower tumbler has the form of a regular pentagon measuring 1 ft. 10⅞ in. on its sides, each side corresponding to one link of the bucket chain. The links of this chain are 2 ft. 2¾ in. long between the centres of the connecting pins, and they are shown by Figs. 4 and 5 on page 247. Circular flanges 4 ft. 5 in. in diameter and of the outline shown in the plan, Fig. 4 just referred to, are fitted to both top and bottom tumblers to prevent the chains from leaving them.

The bucket ladder, which unites the axis of the two tumblers and carries the guide rollers for the bucket chains is 57 ft. 1 in. long between the centres of the tumbler axes. It is of sufficient length to allow of a depth of 28 ft. being dredged with an inclination of the ladder of 45°, while when in its raised position the axis of the lower tumbler is brought to the deck level and the inclination of the ladder is 15° with the horizontal. The ladder is composed of a pair of girders each 2 ft. 11½ in. deep in the middle and 1 ft. 7½ in. deep at the ends, these girders being placed at a distance apart laterally of 4 ft. 3½ in. from centre to centre. Each girder has flanges 0.47 in. thick, and 7½ in. wide—the width of the ladder over all being thus 4 ft. 11 in.—while the webs are of plates 0.196 in. thick, and are connected to the flanges by 3½ in. by 3½ in. by 0.39 in. angle irons. The ends of the girders are strengthened by 6 in. T-irons rivetted to the flanges, as shown in Fig. 5, on page 247.

The two girders forming the bucket ladder are connected by seven double-cross girders, as shown in Fig. 2, page 246, these cross girders having double webs of 0.19 in. plates placed 9.8 in. apart, and connected by angle irons to flanges 15 in. wide. The cross girders are situated at a distance apart of 8 ft. 8 in. from centre to centre. The two extremities of the bucket ladder carry the plummer blocks for the axes of the tumblers. These tumblers are 3 ft. 5 in. wide over all, and they are made of cast iron, each, however, being surrounded by two steel bands placed 19⅝ in. apart from centre to centre, the position of these bands being thus such that they receive the bucket chains. The rollers which support the chains with the loaded buckets are twelve in number; they are made of cast iron 1 in. thick, are 10½ in. in diameter, and are placed 4 ft. 1½ in. apart from centre to centre, as shown by Figs. 1 and 2, page 246.

The buckets are made of wrought-iron plates 0.19 in. thick, and each contains 7.84 cubic feet. Their shape and construction are shown by Figs. 5 and 6 on page 247. The chain carries 29 buckets. The links of the chain are of wrought iron, and the holes through which the connecting pins pass are bored out, and all fitted with steel bushes 0.47 in. thick, which are held by shrinking the links on them.

The spoil raised by the buckets is deposited on a short and steeply inclined wrought-iron shoot, which conducts it to the barges, and the arrangement of which is shown by Figs. 1 and 2 on page 246.

The motive power of the dredger consists of a pair of engines with cylinders 12½ in. in diameter, and 21½ in. stroke, arranged as shown in Figs. 1 and 2 on page 246, the connecting rods being coupled to cranks at opposite ends of an intermediate shaft, as shown. The engines are fitted with link motion, and are supplied with steam by two cylindrical boilers, each 5 ft. 5 in. in diameter by 8 ft. 2½ in. long, these boilers each having an internal flue and return tubes. The firegrates are 1 ft. 11½ in. wide by 4 ft. 5½ in. long.

The arrangement of the gearing is as follows: On the crank shaft of the engines are two bevel wheels, which respectively give motion to two other bevel wheels of the same diameter on lines of shafting running on either side of the well for the bucket ladder. Each of these shafts gives motion to gearing, h (see Fig. 2, page 246), of which the wheels are in the proportion of 13 to 17, and through each set of this gearing motion is given by a pair of bevel wheels, b (having the proportion of 11 to 24) to an inclined shaft which leads upwards, as shown by the dotted lines in Fig. 1, page 246. Each of these inclined shafts carries at its upper end a bevel wheel which gears into another bevel wheel at the end of the upper tumbler shaft, the ratio of these last-mentioned pairs of bevel wheels being 1 to 3. It will be seen from what we have said that the whole system of transmission is double, the sets of gearing on opposite sides of the bucket well being duplicates of each other. The large bevel wheels which we have mentioned as being placed on the ends of the longitudinal shafting are not rigidly attached to this shafting, but each is connected to its shaft by the arrangement of friction clutch, shown in Fig. 2, page 247, the shaft being thrown into gear by bringing the friction wheel, K, into contact with the plane face of the wheel, L. The friction wheel, K, rotates with the shaft, but is capable of being shifted on it longitudinally, while the bevel wheel, L, is loose on the shaft, and only communicates motion to the latter when the friction wheel is forced into contact with it.

The windlass for raising the lower end of the bucket ladder is also driven from the main engine by gearing. This windlass is shown by Figs. 1 and 2 on page 247. A forked lever is made to act upon the extremity of the shaft on which the wheels, M and N, are placed, and is made to break or establish frictional contact between the friction wheel, M, and the wheel, L, which receives its motion from a bevel wheel on the crank shaft of the engine, as already explained. Fig. 3, on the present page, shows the arrangement of the four pairs of wheels forming the gearing of this windlass. The diameters of the various wheels over their pitch circles, and the number of teeth they contain are as follows: Pinion N, 12.6 in. in diameter and 25 teeth; wheel O, 36.22 in. in diameter and 78 teeth; pinion P, 10.24 in. in diameter and 15 teeth; wheel Q, 33.46 in. in diameter and 53 teeth; pinion R, 11.02 in. in diameter and 14 teeth; wheel S, 26.77 in. in diameter and 35 teeth; pinion T, 9.45 in. in diameter and 11 teeth; and wheel U, 55.19 in. in diameter and 64 teeth. The hoisting tackle consists of two pairs of triple blocks, one of each pair being attached to the lower end of the bucket ladder, and the other being hung from the bridge by which the end of the well is spanned, as shown in Fig. 4, page 246. A 1 in. chain is rove through each of these pairs of blocks, and led over pulleys in the bridge down to the winding drum of the windlass of which we have speaking. In lowering the ladder the friction wheel, M, is thrown out of gear, and the rotation of the winding drum is checked by a brake.

The windlasses, fore and aft, and also the two on each side, by which the movements of the dredger are controlled, are likewise driven from the main engine. These latter windlasses, one of which is shown by Figs. 6, 7, 8, and 9, page 247, are driven from lines of longitudinal shafting, f, which run along a short distance beneath the deck, one on each side of the vessel. These lines of shafting are each driven by a pair of spur wheels, i, Fig. 1, page 246, having the proportion of 1.1 to 1, and each of the windlasses of which we are speaking derives its motion from one of these lines of shafting through the intervention of equal sized bevel wheels and bevel friction gear having the proportion of 1 to 3.

The transmission of the motion to the side windlasses is such that the dredger is moved laterally about 5 in. each time that a bucket makes a cut, this lateral displacement not taking place in a strictly straight line, however, but in an arc of a circle struck from the position of the forward anchor as a centre. The diagram Fig. 5, page 246, shows the manner in which the lateral movement takes place. The dredger is caused to move to and fro laterally between the extreme portions shown by the dotted lines, and after each oscillation the side anchors are moved; the forward anchor, however, not being shifted until about 200 fathoms of chain have been payed out.

The height of the bed or layer operated upon by the buckets varies in the case of tenacious ground from 20 in. to 30 in., successive "cuts" being taken so as to remove the stuff to the required depth by layers. In the case of sand, however, the full depth to be dredged is dealt with at once, the buckets often operating on a slope from about 8 ft. to 11 ft. high.

When dredging in heavy clay, the chain makes a complete turn in 2 minutes 30 seconds, this corresponding to a speed of 5.8 turns per minute of the upper tumbler. When dredging in sand, however, the speed of the upper tumbler is nine turns per minute, the chain thus making its complete circuit in about 1 minute 37 seconds. The speed of the chain thus varies from about 60 ft. to 80 ft. per minute. The dredger raises on the average about 164 cubic yards of spoil per hour, while the maximum quantity is about 220 cubic yards.

The cost of dredging, not including the transportation and discharge of the spoil is 3.89d. per cubic yard, a cost very far above that incurred on the Clyde and Tyne and other situations in this country, where extensive dredging operations have been carried on. The cost of the dredger we have described—including anchors, cables, duplicate parts, and all fittings, &c.—was about 7200*l.* In conclusion, we should state that we are indebted to our contemporary, the *Portefeuille Economique des Machines*, for particulars of the dredger which we have given above.

INDIAN RAILWAYS.

To the Editor of Engineering.

Sir,—In the review of Mr. Juland Danvers's report on Indian railways for 1870-71 in your number of August the 18th, referring to the expenditure in the different locomotive departments, you mention that the Bengal lines have, at present, an advantage over those on the west coast and Madras in the supply of native coal; but you state that there appears to be no sufficient reason why the locomotive departments of the Great Indian Peninsula and Bombay, Baroda, and Central India Railways should be so much higher per train mile than the Madras and Great Southern of India.

There is in reality very sufficient reason. The Bombay, Baroda, and Central India Railway uses nothing but seaborne coal from England or Australia, and the Great Indian Peninsula Railway is in almost the same position, the amount of country coal used by that company up to the present time being insufficient to materially affect expenses.

The Madras lines, on the other hand, have a supply of wood fuel at low cost; the Madras Railway uses only a small proportion of coal, about one-ninth of the total quantity of fuel burned.

In the train loads worked there is also a great difference. The combined average train on the Bombay, Baroda, and Central India line, putting together goods trains, mixed trains, mail and short passenger trains, and including even returned engines with brake-vans, and without other load, is 25 to 28 vehicles per train in different half years, while the average train loads on the Madras Railway are from 15 to 16 vehicles. The Great Indian Peninsula also has a higher average train load than the Madras lines.

In the presence of such large differences in the load the cost per train-mile does not constitute a fair comparison; the railway which works the larger trains has correspondingly less train-mileage over which to distribute expenses, while the absolute cost of working each mile is at the same time increased by the greater load. The comparison should be rather per vehicle-mile, or still better per ton mile. The cost of the Ghaut incline working should also be taken into account in the case of the Great Indian Peninsula Railway.

There is a considerable difference in the wages of artisans and labourers between the Bombay and Madras Presidencies in favour of the latter, upon which I need not enlarge, but only remark that the effect of it is chiefly felt in the locomotive departments employing skilled labour.

I am, Sir, your obedient Servant,

Bombay, September 19, 1871. C.

Hydraulic Gold-Washing Company.—A company with a proposed capital of 350,000*l.* is in course of formation for the purchase and working of certain auriferous gravel beds and water rights in California. The former property is situated close to Placerville, about 50 miles from Sacramento, and the water rights consist of some 140 miles of existing canals, drawing their supply from the south fork of the American river. The gravel beds comprise about 70 acres, averaging 135 ft. in thickness. Of this some 25 acres have been worked during the last 17 years, including gold-bearing quartz veins that run through the formation. It is estimated that a sum of 65,000*l.* will have to be expended in improving and extending the canals, and that after this work has been done large and profitable results may be looked for. The estimated profits would be derived from two sources—the hiring out of the water and the realisation of the gold. The capital of the company is to be allotted in 10*l.* shares. Of this amount 15,000 ordinary shares drawing deferred dividends, 1500 preference shares, and 60,000*l.* in cash are to be paid to the proprietors.

BAUSCHINGER'S INDICATOR EXPERIMENTS ON LOCOMOTIVES (*See page* 245.)

TABLE VII. Showing Results of Experiments made by Professor Bauschinger and Herr Zorn, Locomotive Superintendent, Augsburg

1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Class of engine.	Extension of trip.			Time occupied on trip.		Nature of work.			Mean speed of engine.			Mean period of admission.		Work done.			Consumption of fuel.		Consumption of water.		Consumption of steam.					Consumption of stores per square foot per hour.				
	Names of stations between which the trips were made.	Distance between stations.	Total rise or fall in feet.	Including all stoppages.	Actual running time.	Class of train.	Composition of train.	Meteorological observations.	Number of revolutions of driving wheels per minute.	Mean speed of piston in feet per second.	Mean boiler pressure in pounds per square inch.	Distance travelled by piston during admission ÷ by length of stroke.	Actual admission, including clearance spaces.	Total number of foot-pounds of work developed during trial.	Mean indicated horse power developed during trial.	Description of fuel consumed.	Total quantity of fuel consumed.	Fuel consumed per indicated horse power per hour.	Total quantity of water evaporated.	Quantity of water used per indicated horse power per hour.	Calculated from contents at beginning of expansion—contents at beginning of compression.	Compared with Column 19. (Contents of water.)	Calculated from contents at beginning of release—contents at beginning of compression.	Compared with Column 19. (Contents of water.)	Difference between Columns 22 and 24.	Fuel consumed per square foot of firegrate per hour.	Fuel consumed per square foot of heating surface per hour.	Water evaporated per square foot of firegrate per hour.	Water evaporated per square foot of heating surface per hour.	Water evaporated per pound of fuel consumed.
		miles.	ft.	h.m	h.m.					ft.	lb.	per cent.	per cent.	foot-pounds.	IHP		lb.	lb.	lb.	lb.	lb.	per cent.	lb.	per cent.	per cent.	lb.	lb.	lb.	lb.	lb.
A	Augsburg—Munich	53.2	+ 106	3.6	2.16	goods	43 wagons	fine, no wind	79	5.3	110	32	36	931,000,000	222	peat of 18 lb. per cubic foot	8,190	9.7	15,854	31.4	8,937	44	12,067	24	20	109.8	1.36	346.0	4.4	3.2
	Munich—Augsburg	39.2	— 106	2.44	1.48	"	34 "	"	101	6.7	102	26	30	615,000,000	185		4,972	9.2	10,337	31.2	4,972	52	8,004	23	29					
	Augsburg—Guenzach	52.8	+1069	4.7	3.3	goods (2 engines)	40 "	fine, very warm	84	5.6	110	34	38	1,376,000,000	244	peat of 9.5 lb. per cubic foot	5,025	7.0	20,774	27.9	12,441	40	17,767	14.5	25.5	97.8	1.28	387.0	4.95	4.0
	Guenzach—Augsburg	52.8	—1069	2.54	1.46	passenger (2 engines)	16 carriages	{cold wind / against train}	125	8.3	83	20	24	459,000,000	140		1,662	6.7	8,747	35.3	2,621	70	6,188	29	41	44.6	0.56	232.1	2.97	5.32
B	Augsburg—Kempten	64.8	+ 704	2.33	2.2	express	7 "	fine and warm	147	9.8	101	29	33	812,000,000	216	peat of 16.7 lb. per cubic foot	3,507	8.0	11,480	26.1	6,740	49	9,997	21	19	105.2	1.33	346.5	4.4	3.3
	Kempten—Augsburg	64.8	— 704	2.27	1.52	"	6 "	"	157	10.5	89	23	27	441,000,000	128		2,004	8.3	6,943	29.1	3,405	51	5,707	18	23	63.46	0.73	217.8	2.75	3.5
	Augsburg—Lockhausen	31.2	+ 86	2.19	1.45	goods	41 wagons	cold, no wind	81	5.4	110	33	37	627,000,000	194		2,922	8.6	9,940	29.0	5,706	42	7,791	21	21	96.86	1.23	326.7	4.18	3.4
C	Nuernberg—Bamberg	37.6	— 237	1.24	1.8	express	7 carriages	stormy and rain	170	10.4	87	49	52	448,000,000	214	coals	2,750	5.5	7,381	30.4	5,507	25	6,890	15	10	92.4	1.22	524.7	6.93	6.27
	Bamberg—Neuenmarkt	47.0	+ 369	1.54	1.38	express (2 engines)	7 "	"	158	9.7	88	44	47	481,000,000	188	"			8,200	31.5	5,486	33	6,418	22	11					
	Neuenmarkt—Bamberg	47.0	— 369	1.44	1.16	express	6 "	fine, cold	180	11.0	90	37	40	344,000,000	147	"	...	...	6,287	33.7	3,770	40	4,590	27	13	...	...	...	...	...
	Bamberg—Nuernberg	37.6	+ 237	1.25	1.9	"	6 "	cold side wind	169	10.3	97	40	43	370,000,000	174	"	...	...	6,122	30.5	3,861	37	4,744	23	14	...	...	...	...	...
D	Fuerth—Kitzingen	45.1	— 152	3.46	1.35	goods	30 wagons	fine, warm	115	8.3	102	25	30	751,000,000	286	"	...	...	13,229	32.5	5,445	59	8,659	34	25	...	...	...	...	...
	Kitzingen—Wuerzburg	14.1	— 82	1.7	0.27	"	"	"	94	6.8	103	29	34	275,000,000	330	"	...	...	4,646	31.2	2,161	53	3,714	31	22	...	...	...	...	...
	Wuerzburg—Bibart	30.5	+ 440	2.44	1.14	"	"	"	121	8.7	101	27	32	707,000,000	310	"	...	...	12,679	33.0	5,513	56	8,192	25	21	...	...	...	...	...
E	Augsburg—Kempten	64.8	+ 704	2.38	2.7	express	5 carriages	strong wind	136	8.3	71	20	25	596,000,000	152	peat of 14 lb. per cubic foot	3,514	11.0	11,480	35.6	6,784	41	11,082	3.5	37.5	120.4	1.62	3.894	0.94	2.3
	Augsburg—Kempten	64.8	+ 704	2.35	1.55	"	6 "	fine	145	8.9	77	20	25	583,000,000	164		2,898	9.2	10,551	33.4	6,687	37	9,900	6	31	100.4	1.50	365.2	5.61	3.6
	Kempten—Augsburg	64.8	— 704	2.26	1.38	"	7 "	"	143	9.0	75	18	20	379,000,000	125		2,156	10.5	6,943	33.8	4,155	40	6,870	1	39	79.6	1.21	255.3	3.85	3.2
F	Nuernberg—Pleinfeld	37.2	+ 289	2.21	...	goods (2 engines)	53 wagons	rain, cold	94	5.2	77	40	44	261,000,000	94	coals	...	...	5,630	40.0	3,801	33	4,100	27	6	...	...	...	...	...
	Nuernberg—Bamberg	37.6	— 237	1.26	...	passenger	7 carriages	fine, cold	161	9.0	73	33	37	256,000,000	117	"			4,646	33.5	3,733	20	4,709	0	20					
	Bamberg—Nuernberg	37.6	+ 237	1.30	...	"	6 "	"	132	8.4	76	39	43	301,000,000	128	"	2,200	7.0	6,068	37.2	4,600	24	5,464	10	14	79.2	1.48	283.0	7.26	5.39
G	Bamberg—Lichtenfels	20.2	+ 77	1.18	0.59	goods	40 wagons	fine, warm	108	7.2	100	42	45	310,000,000	170	"			5,740	34.5	4,438	23	5,462	5	18					
	Lichtenfels—Neuenmarkt	26.7	+ 292	3.42	1.37	"	"	"	101	6.7	97	49	52	626,000,000	233	"	5,060	7.5	12,846	37.9	9,356	27	10,406	19	8	59.4	0.92	310.2	4.73	5.72
	Neuenmarkt—Lichtenfels	26.7	— 292	2.20	1.17	"	50 wagons	"	99	6.6	100	39	42	314,000,000	131	"			7,653	45.0	4,787	37	5,519	27	10					
H	Stockheim—Hochstadt	15.5	— 240	1.13	0.40	mixed	{18 wagons / 6 carriages}	snow	101	6.7	74	24	30	167,000,000	135	"	650	6.7	3,780	41.1	2,094	44	2,591	32	12	44.0	0.69	263.4	4.39	6.71
	Hochstadt—Stockheim	15.5	+ 240	1.18	0.54	"	{11 wagons / 7 carriages}	cold	99	6.6	71	42	47	267,000,000	160	"	880	6.0	5,358	37.1	3,544	32	3,966	26	6	59.4	0.94	364.1	5.73	6.71
	Stockheim—Hochstadt	15.5	— 240	1.11	0.36	"	{11 wagons / 6 carriages}	snow and rain	110	7.3	69	49	53	157,000,000	141	"	...	...	3,389	40.0	2,150	38	2,362	30	8	...	...	...	...	...

STEAM ON CANALS.

The *American Artisan* publishes the following particulars of a trip made by the Andrew H. H. Dawson, a canal steamer fitted up with the arrangement of screw propeller designed by Mr. T. Main, and illustrated and described by us on page 198 of our last volume. Our contemporary says:

"The Dawson, after steaming up the river from New York to Albany, with a cargo of 180 tons of coals, entered the canal and left for Buffalo August 4, making the trip from Albany to Buffalo in 8½ days, running time; and, on the return trip, leaving Buffalo August 28, with a cargo of 6400 bushels of corn, and about 6 tons of coal, or nearly 190 tons in all, made the run from Buffalo to Troy in 7 days, running time.

"The boat is built with very full ends, is 96 ft. long by 17 ft. 2 in. wide by 9 ft. deep, or 6 in. less in width than many of the boats are, and carries very well for her width. The draught of water each way was 5 ft. 4 in. nearly.

"There is one upright engine cylinder, 12 in. diameter by 12 in. stroke, with an upright boiler, and a common screw propeller, located in the centre of the bow, in a cavity which terminates about 20 ft. aft.

"At times, after cleaning the fire, and when there was a heavy atmosphere, the steam pressure would be reduced, and the speed of the boat would diminish. Again, when the steam was good (say 80 lb.), with a clean fire and a clear atmosphere, and the canal 7 ft. deep, the speed would be full 8 miles an hour.

"The run from Buffalo to Lockport, of 31 miles, was made in 10 hours. From Lockport to Rochester, over the 60 mile level, in 24½ hours. From Lodi Lock (near Syracuse) to Utica, over the 60 mile level in 24 hours. The first 5 miles on this level, from Lodi east, was run over in 1 hour, against a current. The run from Schenectady, west to the first lock, of 3 miles, was made in 1 hour. For a considerable part of the way the levels were low, and the speed would diminish; on the other hand, where there was deep water, the speed would increase to from 3 to 4 miles an hour, which shows that the canal might be 8 ft. deep between the locks with advantage.

"The low levels are due, first, to the dry weather and a deficient supply from the reservoirs, making the canal feeders low; second, to the locking of timber rafts through, which uses much more water than boats, as they do not fill the lock; and, third, to the practice of drawing loaded boats into the locks by opening the sluices in the lower gates, and by swelling the loaded boats out of the locks by opening the sluices in the upper gates.

"The Dawson went into and out of the locks with ease, and did not require swelling. Where the leakage of the lock-gates is great, there is also a tendency to lower the levels. The two summit levels of Jordan and Rome are the most liable to be low, on account of locking down from both ends. The Jordan level in particular (the first that was enlarged) is both narrow and shallow.

"One marked feature in the progress of the Dawson is the entire absence of any swell or wave. This is due to the action of the screw producing a current under the boat, preventing a swell at the bow and a suction at the stern. This boat, drawing 6 ft., will displace 300 tons of water, and in moving her own length this amount of water must move from in front and go behind. The screw in the front facilitates this operation, as the current underneath the boat produces an induced current on either side, and so facilitates the displacement of the water in the front and the replacement of it behind the boat.

"The passenger propellers running east, from Syracuse to Manlius and Utica, when going at full speed can easily raise a bow swell which will wash over the canal banks on either side, and tear all the loaded boats loose which are moored along the canal. One of them, when passing the Dawson, loaded and moored to the dock at Syracuse, made her tear away a ring-bolt of ¾-inch iron, broke her mooring lines, and set her all adrift. On the other hand, the Dawson passed hundreds of boats under similar circumstances, and did not affect them at all. The same cause (namely, the current underneath) prevents any settling or squatting of the boat, as she draws the same amount of water when at rest as when under a full headway.

"She passes over the tow lines of other boats without any trouble. She also passes loaded boats going in the same direction with great facility, for the induced current on the side holds the other boat still while the steamer is passing.

"This boat being somewhat experimental, of course can be improved on; but the results of this trip show that with a good model of a boat, a little surplus power, to be used in passing boats and in stemming the currents near Buffalo, a preference in going through the locks, and if possible, the canal deepened between the locks to from 7 ft. to 8 ft. there would be little left to be desired for navigating the canal by steam.

"If iron boats were used, the carrying capacity would be increased, as the hulls would be lighter. The enlargement of the canal for vessels of 500 to 600 tons may be a question for future consideration; but at present, even if water could be found along the line to feed the enlarged canal, the enormous cost, the time and inconvenience, of making the change would prevent its consideration."

Australian Coast Navigation.—A meeting has been held at Bulladellah to take into consideration the advisability of establishing steam communication between Port Stephens, Booral, Newcastle, and Sydney. A local committee has been formed to forward the project.

ALBERT BRIDGE FOUNDATION CYLINDERS.

A cylindrical casting of unusual magnitude has just been successfully turned out by Messrs. Robinson and Cottam, of the Battersea Foundry. This is the first of the bottom or cutting rings of the piers for the Albert Bridge, now in course of construction over the Thames at Chelsea. There will be four river piers, placed in pairs, and carrying the four towers. The cylinders of these piers will be cylindrical, the cutting ring being 21 ft. in diameter, and 4 ft. 6 in. high. The next ring above this will be 5 ft. high, and will taper from 21 ft. at its junction with the cutting ring, to 15 ft. at its top. From this point the remainder of the pier will be composed of cylinders 15 ft. in diameter, and 6 ft. high. The first of these cutting rings was successfully cast on Tuesday evening, and on inspecting it yesterday we found it still warm. The metal in this ring averages about 1¼ in. thick, and it has been cast in loam. The estimated weight of the cone, which was of brick and iron, was 18 tons 10 cwt., and 40 tons of iron were used in and about the mould and core. The weight of iron melted for the cylinder was 13 tons, the run being made from three points in the diameter of the ring. The estimated weight of metal in the ring is 10 tons. The iron used was Calder No. 1, and picked scrap, and the casting has turned out successful in every respect. Of course heavier and larger castings than this have been made for years past in the shape of beds for steam hammers, and of girders some 60 ft. in length. But this, we believe, is the largest cylinder ever cast in one piece, the usual method having been to cast them in segments, and bolt them together by means of internal vertical flanges, as in the case of various bridges over the Thames having cast-iron cylindrical piers. We may observe, however, that the cylinders of the piers for the Rochester Bridge were cast in one, and were 7 ft. in diameter. Some still larger cylinders were cast for the main drainage pumping stations—we believe 8 ft. in diameter. Messrs. Robinson and Cottam have also cast cylinders 12 ft. in diameter, but not for bridge work. The present casting, therefore, stands on record as being of the largest diameter ever successfully attempted. The works at the Albert Bridge are progressing favourably, being ready to receive the cylinders as they are cast by Messrs. Robinson and Cottam. The mould and core for the second cylinder are nearly ready.

MR. JOSEPH HAMILTON BEATTIE.

It is with regret that we have to announce the death of Mr. Joseph Hamilton Beattie, who for some years past has held the appointment of locomotive engineer to the London and South-Western Railway Company. The deceased gentleman had been ailing for some little time past, and died at 4 o'clock on Wednesday afternoon, the immediate cause of his death being diphtheria. Mr. Beattie was 67 years of age, and was practically brought up under his father as a builder and contractor. He subsequently became connected with the late Mr. Joseph Locke, and was at first employed on the Grand Junction Railway. After a time his services were transferred to the London and South-Western Railway. He served for two years as an assistant engineer on that line, and afterwards for 9 years as one of the resident engineers. Since the year 1850, and down to the present time, Mr. Beattie has had the entire charge of all the machinery, locomotives, and rolling stock on the above railway. His name will be remembered in connexion with many practical improvements in the details of the locomotive engine.

THE VIENNA EXHIBITION, 1872.

Some months since a proposition was actively set on foot to hold an international exhibition in Vienna next year. Commissioners were duly appointed, and designs were prepared for the building, which is to consist of a central hall surrounded by various annexes. The central hall, which is the principal feature of the building, is circular in plan, its diameter being about 345 ft. The hall is surrounded by 30 hollow wrought-iron pillars, rectangular in plan, and 80 ft. in height. From the tops of the pillars springs a circular conical roof carried on straight ribs, and set at a pitch of about 40 degrees with the horizon. The central opening in this roof is 100 ft. in diameter, and is surmounted by a drum of the same size, and having a conical roof. On the top of this drum is a lantern 80 ft. in diameter, the summit being surmounted by an imperial crown. The height from the floor of the building to the crown is 250 ft. The weight of metal in the building is estimated at 2300 tons. Tenders were invited from English and foreign engineering firms for the supply of material and erection of the central hall, and we learn by a telegram which has just been received in England that the successful competitor is M. Harkort, whose works are situated near Duisberg in Rhenish Prussia. We hope shortly to place detailed particulars of the Vienna Exhibition buildings before our readers.

The Demerara and Trinidad Telegraph Cable.—The West India and Panama Telegraph Company have received a telegram announcing the successful laying of the section of their cable between Demerara and Trinidad.

MORRISON'S LOCK FOR RAILWAY CARRIAGE DOORS.

FIG. 1

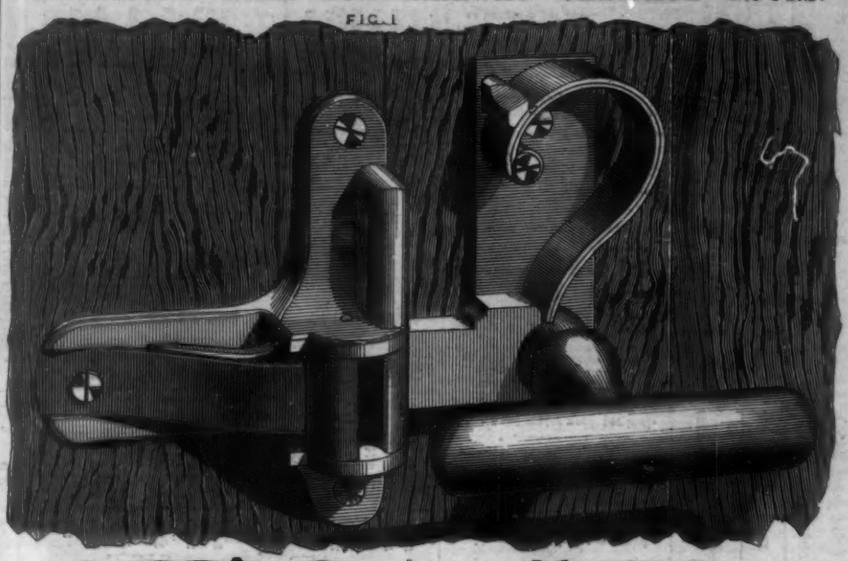
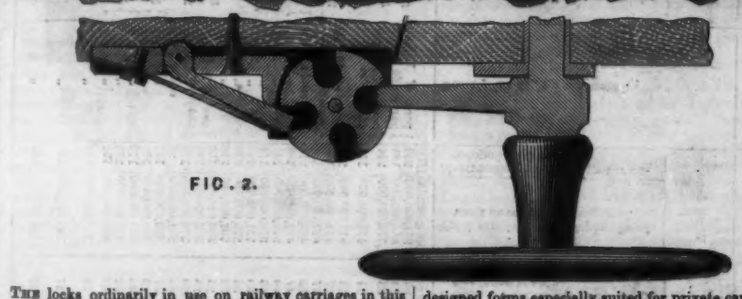


FIG. 2.



The locks ordinarily in use on railway carriages in this country, are, as is well known, so constructed that the door can only be secured by the handle being turned by hand. In the case of trains making frequent but very brief stoppages, as is the case on the numerous metropolitan lines, this turning of the handles involves considerable trouble, and there is at all times a risk of some doors being left unsecured. On the Continent this trouble has led to the extensive application to railway carriage doors of spring latches similar to those in use on ordinary doors; but these latches are scarcely so reliable as could be desired, and they are very generally supplemented by a second lock or equivalent fastening secured by hand. Recently a new arrangement of fastening for carriage doors has been brought under our notice, and as it possesses several very good features, we have had prepared the engravings of it which we now publish.

In this new lock, which has been designed and patented by Mr. J. Morrison, of 15, Chatsworth-road, Stratford, E., the parts which are moved when the lock is opened are distinct from those which operate when the door is closed. Referring to the engravings, it will be seen that the handle, spindle, and tongue of the lock are constructed in the ordinary way, except that the tongue is so shaped that the action of the spring tends to force it constantly into the horizontal position. Thus when the door is opened and the handle released, the latter at once becomes horizontal, and the tongue is brought into the proper position for being caught by the arrangement of revolving catch cylinder which we shall now explain. Referring again to the engraving, it will be seen that the casting attached to the door pillar carried a grooved cylinder, which is capable of revolving on a vertical spindle and the four grooves or notches of which are of sufficient size to receive the end of the tongue of the lock. The grooves also serve to receive a detent, which is kept up to its work by a spring, as shown, and which serves to prevent the cylinder from rotating but in one direction.

When the door is closed the tongue of the lock strikes against one of the "teeth" left between the grooves in the revolving cylinder, and turns the latter one-fourth of a revolution, the effect of this being that the tongue is held securely by the tooth succeeding that against which it struck, while the cylinder is prevented from turning backwards by the detent. The resistance to the rotation of the cylinder in the one direction being very small, a very slight pressure suffices to shut and secure the door, and in this respect Mr. Morrison's lock compares very favourably with ordinary spring latches, there being no necessity for severe slamming of the doors where it is employed. The contrivance is also one which presents no difficulties of manufacture, so that it can be produced at a moderate cost, and we see nothing about it likely to get out of order.

Our engravings have been prepared from an outside lock suitable for third-class carriages; but Mr. Morrison also makes mortise locks on the same principle, and he has also designed forms especially suited for private carriages. There can be no doubt about the convenience of a spring lock of this kind, and we hope that Mr. Morrison's plans will have a fair trial. We should mention, in conclusion, that Mr. Morrison's locks are being fitted to two carriages on the Great Eastern Railway.

Progress in New Zealand.—A large graving dock, constructed at Port Chalmers in the province of Otago, New Zealand, has been opened with the ceremonies usual on such occasions. Port Chalmers has been selected as the port of rendezvous for the steamers established between New Zealand and San Francisco.

Thomson's Road Steamers.—One of Thomson's road steamers, imported by the Provincial Government of Wellington, New Zealand, has arrived out. The last advices from Wellington state that it had been put together, and had made a successful trial trip through some of the streets of the town, several of which present heavy inclines. How the steamer will fare on the rough roads of the country districts remains to be seen.

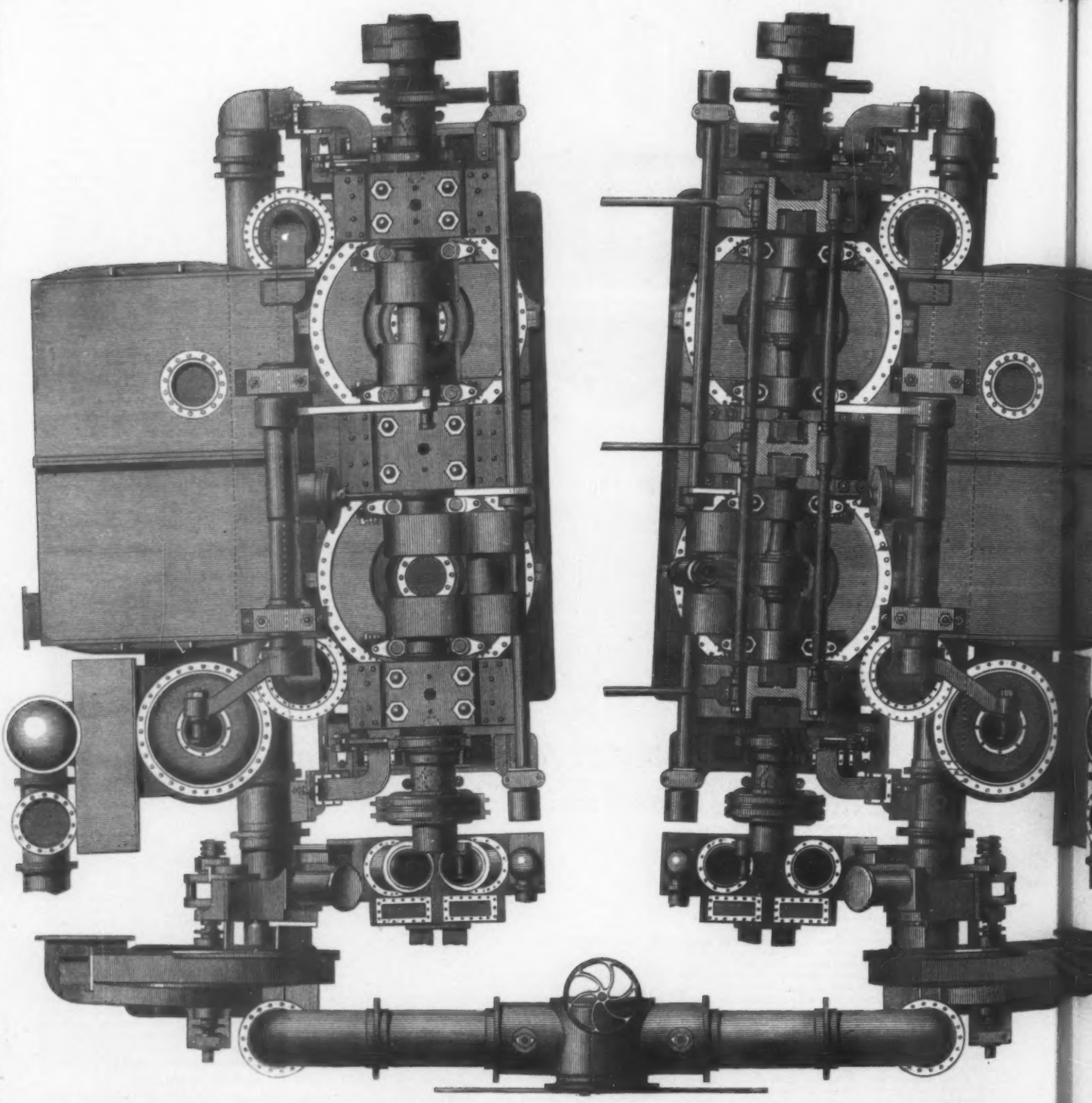
Eastern Bengal Railway.—An official report, by Lieut.-Colonel Taylor, R.E., on the damage sustained by this railway during the severe floods which have recently devastated some parts of India, states that in the vicinity of Parodah three bridges have been washed away. It had been found necessary, as the current was not abating, to cut the bank in four fresh places, so as to pass off the flood, and save the remaining structures. A ferry had been organised over a length of about 3 miles; as soon as the rush of water abated the gaps would be filled up, and temporary pile bridges would be erected over the regular water-courses.

The Late Fire in Chicago.—Mr. James O. Heyworth in a letter to the *Times* dated the 15th, points out a probable cause for the rapid and overpowering advance of the fire which destroyed so large a part of the city. He says that while the erection of wooden houses within certain limits is forbidden by statute, there has existed an almost universal practice of constructing the roofs of buildings of highly inflammable materials. The cost of slates is so great as almost to prohibit their employment for this purpose, and houses are for the most part either covered with wooden shingles or with felt paper covered with pitch, and covered with small gravel. In seasons of great heat the pitch softens so much that the gravel is partially absorbed, and becomes exposed, so that it can easily be imagined how after a prolonged drought all buildings covered in this manner would be under the most favourable conditions for ignition, whilst the material would also be exactly such as would be distributed by the wind in burning fragments. It is probable that in this explanation will be found one of the chief causes of the speedy and vast catastrophe.

TWIN SCREW MARINE ENGINES F

CONSTRUCTED AT THE DELAMATER IRON WORKS, N

(*For Descrip*



ES FOR THE "STEVENS BATTERY."

N[illegible] YORK, FROM THE DESIGNS OF MR. ISAAC NEWTON.

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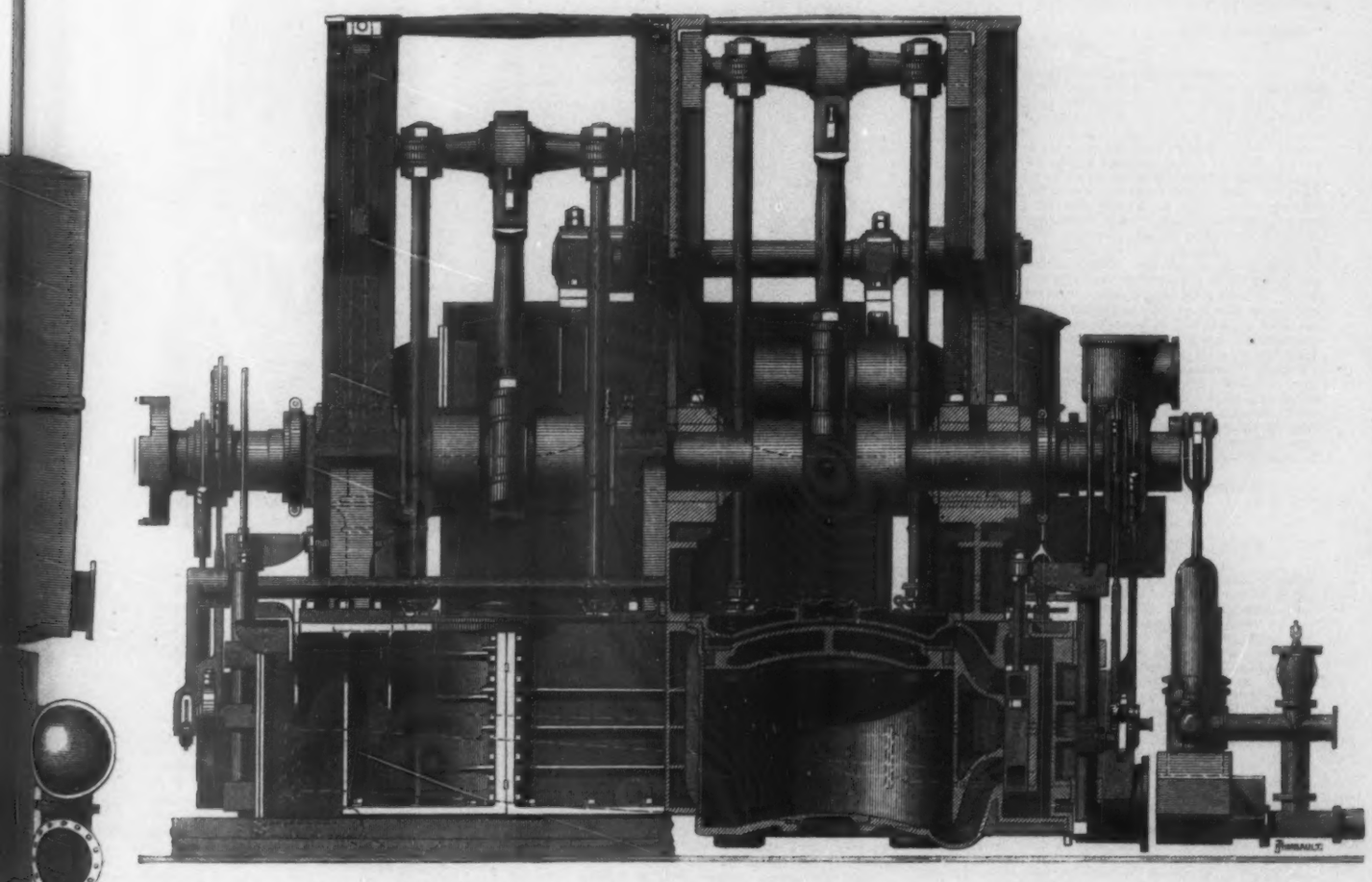
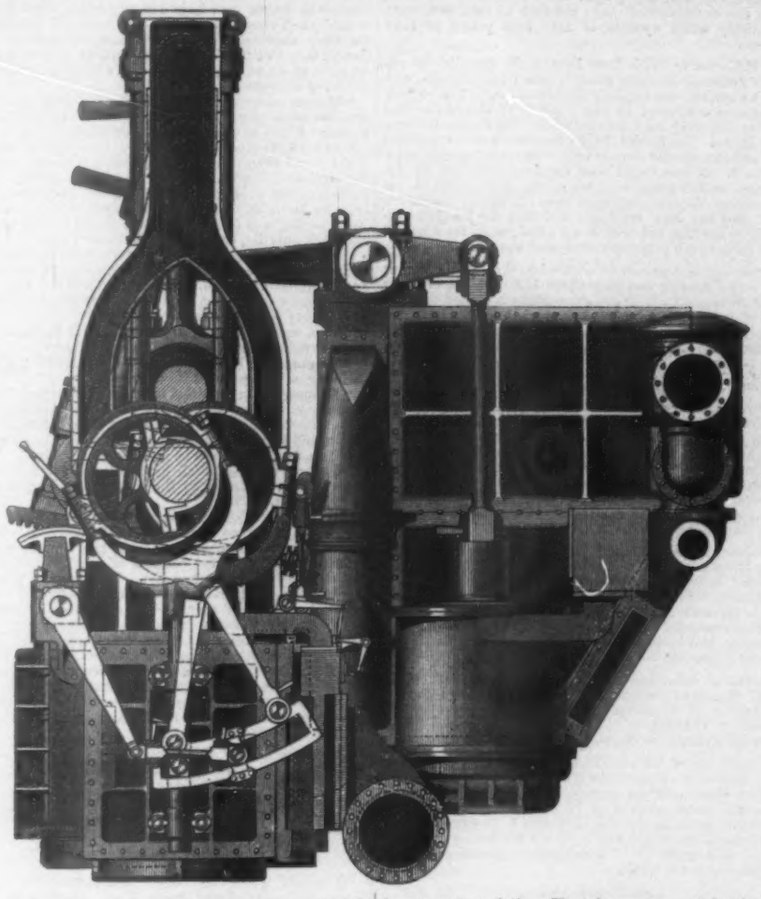


	Ft.	In.
DIAMETER OF CYLINDERS	6	0
LENGTH OF STROKE	3	9

TWIN SCREW ENGINES FOR THE "STEVENS BATTERY."

CONSTRUCTED AT THE DELAMATER IRON WORKS, FROM THE DESIGNS OF MR. I. NEWTON.



The twin screw engines, of which we this week publish a two-page engraving, together with another view on the present page, have been constructed for the celebrated "Stevens Battery" at the Delamater Works, New York, from the plans of Mr. I. Newton, C.E.

The engines were designed so that the contracted and irregular space allotted, to them in the vessel could be used to the best advantage; this is mentioned to show that the designer was governed by good reasons in deciding on the general arrangement of these engines. The space permitted vertical cylinders of good length of stroke to be placed underneath the crank shaft; and, as the vessel is intended to be invulnerable, there is no objection in allowing the upper end of the cross head girder, as well as the cross heads when at their extreme upper movement, to extend to the water line. Again, the internal arrangements of the vessel make it indispensable that an unobstructed passage should be provided at the centre of the vessel between the engines. Bearing these points in mind, an inspection of the plans which we publish, will show that the constructor has designed these large engines economically with respect to space, fulfilling the conditions imposed by the nature of the case, while at the same time the working parts are easily accessible.

The following are the principal dimensions; diameter of cylinders 72 in., length of stroke 45 in.; air pumps 44 in. in diameter, length of stroke 27 in. The steam ports are single, and are 7 in. wide by 36 in. in length; each main slide is entirely relieved from pressure by a rigid saddle plate accurately fitted to the back of it; it is, therefore, wholly balanced so far as regards the action of the steam. The weight of the slide, sliding bar, link and attachments is carried by an atmospheric cylinder, hence the only strain put on the valve gear is by friction.

An independent expansion valve is provided; this consists simply of a gridiron slide working on the side of the main steam chest, and operated by a separate eccentric so arranged that it may be thrown out of gear by placing the valve stem link at the axis of the rock shaft. The cut-off chest and slide being placed on the side, the main slide is accessible without removing it.

The engines are fitted with surface condensers, which together contain nearly ten miles of brass tubes $\frac{3}{4}$ in. in diameter; these tubes are protected on both sides by a heavy coating of tin. The tubes are secured in the tube plates by Allen's method of wood packing, a plan which has been extensively used in this country.

The condensing water is passed through the condensers by two centrifugal pumps driven by independent engines, which are attached direct to the fan shaft. These fans are of large diameter, so that they will circulate an adequate quantity of water when moving at a very moderate number of revolutions. The double throw crank shafts were made up in pieces, and were put together in a very careful manner; the cranks, crank pins, and shafts were each finished separately and then shrunk together, and although after its completion the work was subjected to a very searching examination, not the slightest error in the parallelism of the parts could be ascertained. This mode of construction has been adopted on account of its insuring perfect soundness, besides being somewhat less expensive than the usual method of solid forgings. The crank pins are 15 in. in diameter, and are of steel. The engravings which we publish of these engines are so fully detailed, that a further description is unnecessary. We will merely remark, therefore, that the engines afford evidence of the design having been carefully adapted to the peculiar conditions to be fulfilled, while we should add that the work has been executed at the Delamater Works in excellent style; the accuracy of the finish being admirable.

The boilers which supply these four engines are of the usual horizontal tubular style; they contain 875 square feet of grate, and upwards of 28,000 square feet of heating surface, dimensions which will, we need scarcely say, supply the engines with an abundance of steam.

San Paulo Railway.—This somewhat important Anglo-Brazilian Railway, which is 86¼ miles in length, earned in 1870, 199,258*l.*; and the working expenses having been 78,560*l.*, a net profit of 120,698*l.* remained. The proportion of the working expenses to the traffic receipts last year will be seen to have been only 39.42 per cent. The San Paulo line, deducting the sierra inclines, consists of two distinct lines below and above the sierra, 13½ miles and 68 miles in length respectively, and as distinct lines more costly to work than if they were continuous. On the above sierra line the gradients are often necessarily severe, as there is no leading valley to follow; there is a length of 13¾ miles of gradients varying from 1 in 40 to 1 in 60.

STEAM ENGINE COEFFICIENTS.

We have received the following telegram on this subject from Mr. J. McFarlane Gray:

To the Editor of Engineering.

Sir,—Business travelling has prevented me writing in time for this week's Engineering. Mr. Elder unkindly, but perhaps legitimately, puts another meaning than I intended on the word "presented." I meant merely "showed." I have not claimed to have given assistance to any consulting engineer; my intercourse with superintendent engineers, as sometimes with Mr. Elder when he was one, was always a friendly interchange of ideas, resulting, I hope, in mutual benefit, just as this discussion would be both to Mr. Smith and to myself. The date, September 22, 1860, is not the date of the lithograph, but the date at which the diagrams were taken. The lithograph itself has no date on it. Mr. Smith's correction is a blunder, and my "blunder" is quite correct to the last decimal place. Mr. Smith's advice to J. J. C. is unnecessary. Mr. Smith by regarding J. J. C.'s letter may be yet indebted to J. J. C. for his first knowledge of the ratio of expansion. J. J. C. gives the ratio of expansion without the correction for wire-drawing, whereas I gave ratio as corrected for a wiredrawn admission. J. J. C.'s is exactly what is given by Professor Rankine and all standard authors on this subject, and for their purpose is quite correct. A letter shall be sent next week.

J. McFarlane Gray.

Cork, October 19, 1871.

To the Editor of Engineering.

Sir,—I was rather surprised at the construction Mr. Smith put on the opening sentences of my first letter, in his of last week. After reading my letter over carefully I can find no such virtual statement in the beginning of it, while later on I find something which clearly shows I held no such opinions as Mr. Smith so hastily charges me with; for after dividing the total capacity of low-pressure cylinder by total capacity filled before cut-off in high-pressure cylinder, I say "multiply the quotient by the initial pressure in high-pressure cylinder and divide by the pressure in high-pressure cylinder at point of cut-off," thereby showing that I consider any wire-drawing that may have taken place, as expansion. So that I cannot but regard Mr. Smith's remarks on that point as an ingenious device to avoid or postpone the discussion of the other parts of the letter; especially as those are not "based on such a hypothesis" having nothing to do with wire-drawing. Had he been less off-hand in his dealing with the letter he would have found a real, instead of an imaginary error in it, viz., that what I put down to wire-drawing I really showed to be caused by radiation (printed "reaction") from the receiver. In my haste I also used the word "initial" for "mean" in line fourteen. Does Mr. Smith admit that the low-pressure cylinder being jacketted or not will make a difference in the terminal pressure in that cylinder; and in two engines otherwise alike would he consider the amount of expansion different if such difference of terminal pressure occurred?

Yours respectfully,

London, October 16, 1871. J. J. C.

THE PALLISER-PARSONS BOLT.

To the Editor of Engineering.

Sir,—Observing your remarks under the above heading, it occurs to me that I may as well note that, in 1866, on the 11th of September, or anterior to Mr. Parsons's patent, dated the 5th of February, 1867, I provisionally protected a form of bolt with hollow shank, intended for armour plating, and that, ere this, I brought the hollow bolt under the notice of the Admiralty and of the then Shoeburyness Committee. I am quite aware that a knock-down rejoinder to all such reclamations of priority is made by the question, "Why then did you give it up?" Any slight merit in such things is almost entirely nullified by abandonment. But I venture to think that such a question will not be made by one who has had any dealings with our Government offices.

Obediently yours,

London, October 18, 1871. Frede. A. Paget.

Hamburg Steam Fire Engines.—We have in our columns from time to time referred to Messrs. Shand, Mason, and Co.'s patent equilibrium steam fire engine. The first of these engines was sent to Hamburg in September, 1865, a second in the beginning of this year, and on Wednesday last the steamer Cosmopolitan took out a third. This engine is similar to those sent to Glasgow, Preston, and other places, and is constructed so as to avoid all danger from frost during the severe Hamburg winters.

An American Torpedo Boat.—A new torpedo boat is to be built at the Washington Navy-yard, measuring 175 ft. in length by 45 ft. beam. Her hull will be of iron, 3 ft. out of water. The exposed part will be armour-plated with 5-in. iron backed with wood. She will be propelled by two screws, and her engines are expected to drive her fourteen knots per hour, minimum speed. She will have for fair weather two masts, schooner-rigged. The torpedo will contain 100 lb. of powder, attached to an iron beam which will protrude from the bow below the water-line. This beam will be 25 ft. long, and so adjusted as to be forced out by hand from a water-tight compartment through packing. It will be worked by hand instead of steam, because any unexpected obstruction can be more easily detected that way than otherwise. It is intended, when orders are given to that effect, that the torpedo boat shall make straight, under a full head of steam, for an enemy's ship, run well under her, and explode the torpedo by electricity, the beam being withdrawn at the same time. The boat will be of comparatively light draught, requiring 11½ ft. of water.—*American Artisan.*

FOREIGN AND COLONIAL NOTES.

Great Western Railway of Canada.—During the past half-year the Great Western Railway Company of Canada has constructed 2¾ miles of additional sidings at various parts of the line. Sundry overhead bridges have also been raised to a height of 18 ft. above the level of the track. It has been decided to replace gradually the whole of the iron rails now in the main track with steel rails as the iron rails require renewal. The car stock is being altered to the 4 ft. 8½ in. gauge as fast as possible. The cost of the change of gauge is being gradually borne by revenue.

Indian Railways.—It is affirmed that the Nizam's Railway from Goolburga on the Great Indian Peninsula system to Hyderabad will shortly be put in hand. The estimates and plans are being altered from the broad to the metre gauge. The East Indian Railway, which had been damaged by floods between Umballa and Saharunpore and Umballa and Karterpur, has been again made available for traffic.

The Russian Navy.—The Emperor Alexander has decorated M. Krabbé, the Prussian Minister of Marine, with the Order of St. Alexander Nevski, "in acknowledgment," according to the official bulletin, "of his exertions on behalf of the Russian Navy in the Baltic and of his eminent services in re-creating, organising, and improving the Black Sea fleet."

The German Navy.—When all the works of construction and repair are finished, the German navy will comprise seven iron-clads of an aggregate of 4800 horse power and carrying 77 guns; one vessel of the line (steam), five corvettes (steam), seven despatch boats (steam), 22 gunboats (steam), one transport (steam), one training brig, three other brigs, three frigates, and a ship used as a floating barrack. All these vessels, taken together and adding the iron-clads, carry between them an aggregate of 552 guns.

Coal in Chili.—Coal has been discovered at Neblinto, in the Republic of Chili.

Canals in Victoria.—The promoters of the north-western canal scheme (Victoria), have pressed upon the new Minister for Lands a request for a 999 years' lease of about 3,000,000 acres of land as a subsidy. It is stated that capital has been subscribed for the execution of the work to the extent of 150,000*l.*; but the entire outlay is estimated at 3,000,000*l.*

The Indian P. W. D.—It is stated that Colonel Trevor, R.E., Consulting Engineer for Railways to the Bombay Government, has been offered the post of Under Secretary to the Government of India in the Public Works Department.

Artillery in France.—Great activity continues to be displayed in the production of artillery in France. In the Loire district the cannon foundries are very busily employed. Some breech-loading cannon, upon a system introduced by Colonel Reffye, have been successfully submitted to very severe tests. Some of the cannon made of late have a range of 3¼ miles.

The American Iron Trade.—The Tredegar Iron Works at Richmond, Virginia, now employ upwards of 1200 hands, who are principally engaged on railway *matériel* and equipment. The works are turning out rails, &c., for the Dutchess and Columbia Railroad, the Chesapeake and Ohio Railroad, and numbers of roads in the south and south-west of the United States.

Railway Matters in Ontario.—Mr. Sandford Fleming has left Ottawa for an inspection of a portion of the Intercolonial Railway. Mr. Rowan, who has been engaged in surveys for the great Canadian Pacific line, has returned to Lake Superior. The annual meeting of the stockholders in the International Bridge Company was held at Buffalo, Oct. 4.

Buenos Ayres Tramways.—The receipts of the City of Buenos Ayres Tramways Company (Limited), for the first half of this year, were 18,566*l.*, while the working expenses were 16,426*l.*, leaving a profit of 2140*l.* Since the subsidence of the yellow fever at Buenos Ayres, the company's receipts have been largely increasing. The directors recommend a dividend at the rate of 6 per cent. per annum.

Bessemer Steel in Germany.—A Franco-German Company has been formed under the title of the Rhine Steel Works Company, and has erected some vast establishments for the production of Bessemer cast steel. Tools have also been provided for the transformation of the ingots into rails, tyres, axles, rings for cannons, &c. The greater part of the works are now in activity, and the whole will be in regular operation with the close of the current year.

NOTES FROM THE SOUTH-WEST.

Water Supply of Aberystwith.—The Aberystwith Town Improvement Commissioners have held a special meeting for the purpose of considering whether a better supply of water for the town shall be obtained from the Domen Valley or the Llanbadarn Flats, and also for taking measures for carrying into effect the scheme which may be adopted. On a vote being taken, the Llanbadarn Flats or pumping scheme was adopted by a majority of five, one commissioner remaining neutral. It was also decided that Mr. J. W. Salumper, C.E., should be engaged to draw up plans, and that the necessary steps should be taken for obtaining an Act of Parliament if it should be found that one was necessary.

Newport Alexandra Docks.—A party of the directors and officials of the Newport Alexandra Docks Company, consisting of Lord Tredegar, Sir G. Walker, Messrs. Elliott, Parkinson, E. J. Phillips, G. W. Jones, J. Abernethy, C.E., J. McClean, C.E., A. Bassett, C.E., J. S. Adam (secretary), and Carlyle (solicitor), have visited the works now in progress. They were met by Mr. Griffiths, who acted as guide. The visitors expressed themselves much gratified with the results of their inspection.

Water at Cirencester.—Much difficulty has been experienced in obtaining a supply of water for Cirencester. The town commissioners caused trial borings to be made upon Lord Bathurst's estate near the town, and, finding water in abundance, they submitted it to Professor Church, of the Royal Agricultural College, for analysis. His report is satisfactory, and, acting upon the advice of Mr. Taunton, C.E., the commissioners have resolved to turn to account the supply which appears to have been placed at their disposal.

L'Extincteur.—Trials have been made opposite the engineer's office at the new Bute Works, Cardiff Docks, with Dick's chemical fire engine, "L'Extincteur." The experiments were conducted by Mr. Sinclair, of Manchester and London (licensee), with the assistance of Mr. James A. Hogg, Bute Docks. The results of the experiments were considered very satisfactory—a powerful body of flame being completely overcome. It was stated that inquiries addressed by the licensees to 120 firms with whom the engines are in use showed that they had employed them 317 times; that in 309 cases they had been effectual; and that the damage sustained by the fires had been in all 1691*l.*, while the approximate value of the property endangered was 1,310,190*l.*

Launch of a Steamer.—On Monday, the St. David's, an iron screw steamer carrying about 180 tons, and built for Mr. J. Ware, of Cardiff, was successfully launched from the yard of Mr. J. Batchelor. She comprises all the latest improvements, and is intended to trade between Cardiff and Exeter, in conjunction with the Bristol and Exeter Railway.

Taff Vale Railway.—The traffic of this line appears to be now improving.

State of Trade at Newport.—Large shipments of railway iron have continued to be made from Newport for United States ports. Shipments of bridge work for Buenos Ayres have also been made. Two ships have been taking in rails for Vera Cruz, and a steamer has been loading for Taganrog. American orders are still coming in; they are derived principally from the Southern and Central States. There has been a good inquiry for steam coal, and the clearances have been considerable.

Newport Harbour Commissioners.—At the last meeting of these commissioners it was announced that the harbour dues collected in September amounted to 180*l.* against 171*l.* in September, 1870. The gridiron receipts were 42*l.*, against 29*l.* in September, 1870. Sundry repairs were reported to the commissioners' ballast stages. It was also stated that a conviction had been obtained in connexion with the tipping of rubbish into the Ebbw, a tributary of the Usk.

Survey of Glamorganshire.—A small detachment of the Royal Engineers arrived at Llantrisant on Saturday for the purpose of commencing the Government survey of the county of Glamorgan. Two other detachments of the corps are stationed at Merthyr and Maes-y-cwmwr.

Wages in South Wales.—An adjourned meeting of delegates from the iron works of South Wales and Monmouthshire was held on Monday for the purpose of reporting progress as to a demand for an advance of 10 per cent. in wages. It was decided to make the demand December 1. It was also agreed that deputations should wait upon the masters for a reply on or before December 11. The delegates expressed themselves sanguine as to the result.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a numerous attendance on 'Change at Middlesbrough, and a good deal of business was transacted. Considerable interest was manifested in the wages question which was under consideration by the Board of Arbitration. There was a great demand for all kinds of pig iron, and prices were firm at last week's rates. At present, shipments are active, and quantities of pig iron are being sent away from the Tees to all parts of the world. The home consumption is heavier than ever.

The Finished Iron Trade.—Rails are still in request, and all the mills in the North of England are kept fully engaged on contracts. The bar iron trade is good, and plates and angles although made in such large quantities are yet unequal to the demand. All the other departments of the trade are in a satisfactory state.

The Ironworkers and Mr. Hughes's Award.—Last week we stated that Mr. Hughes, M.P., the arbitrator appointed by the Board of Arbitration to decide the rate of wages in the iron trade of the North of England, would visit Middlesbrough on Monday and give his award. A meeting of the Board of Arbitration was held at Middlesbrough on Monday, and Mr. Hughes attended, and gave his award, which was simply as was anticipated, a confirmation of his previous award in July last. It will be remembered that on that occasion he decided that the men should have an advance of 5 per cent. This decision was not satisfactory to the ironworkers, and they requested Mr. Hughes to verify the returns which the masters had given him and upon which his decision was based. He consented to do this, and sent down from London a well-known accountant who examined the books of the various firms. This course proved that the returns furnished to Mr. Hughes were accurate, and therefore nothing remained for him to do but to confirm his award. On Monday his final decision was very unpopular, and, in fact, was not accepted by the men. The Board of Arbitration received it, but so satisfied were they that the men would not be bound by it until March next, that they at once began to consider how much they could advance the men's wages. The day was occupied in discussing this question, but the Board were unable to agree and adjourned until Tuesday. On assembling yesterday, after the masters and operatives had discussed a proposal for the adoption of a sliding scale for settling wages, the Board came to a decision as follows:

"Although the award of Mr. Hughes in July last, confirmed by his address of October 16, fixes wages up to the end of March, 1872, at the rates prevailing in 1870, the employers have given full consideration to the representations of the operative members of the Board, relative to the changes in wages that have recently taken place in Staffordshire and elsewhere; also to the improved prospects of the trade since the claim of the men was made in July, though they feel that these considerations give no claim to set aside an actual bargain, they are willing to agree to the following arrangements:

"That an advance of 6d. per ton on puddling, and 5 per cent. on other wages be conceded, to take effect from November 1st, and to continue until 31st March, 1872.

"As a condition of this arrangement the operative members of the Board to agree to the introduction of a standard scale for regulating wages after March 31st, according to the realised selling prices of iron. The general features of such scale to be as follows: That the wages to be paid in the North of England be arranged periodically on January 1st April 1st, July 1st, and October 1st in each year.

"That the net prices realised during the three months ending one month prior to each quarter day be ascertained, on the principle adopted, in such manner as the Board may decide, and a declaration be published, under proper authority, setting forth the result.

"That, upon this declaration, wages shall be fixed for the ensuing three months in the following manner:

"No change to be made of less extent than 3d. per ton on puddling, and 2½ per cent. on other wages.

"A change in prices equal to 3d. per ton in puddling and 2½ per cent. in other wages to be made for each fluctuation of 5s. in selling prices above or below the standard, it being understood that 2s. 6d. shall be reckoned as 5s., and anything less than 2s. 6d. shall not be taken into account.

"That the standard shall be 6*l.* 17s. 6d. per ton, realised price of iron, in relation to the wages prevailing now and since July 1st, 1871."

There are other conditions which, however, are not so important as those we have quoted. We may state that on Monday evening a public meeting of iron workers was held at Middlesbrough for the purpose of hearing Mr. Hughes deliver an address on arbitration. There was a very large number of persons present, and we regret to add that the proceedings did not reflect credit upon the iron workers. While Mr. Hughes was explaining the advantages of arbitration, and his reasons for confirming his award, he was interrupted to such an extent that he was unable to proceed, and finally he told the men that their conduct was shameful. Before the meeting separated, however, a vote of thanks was passed to Mr. Hughes, but it was quite evident that arbitration, which did not result in an advance of wages, would not be accepted.

The Nine Hours' Movement.—The movement for the adoption of the nine hours day is making rapid progress. Firm after firm on Tyneside are conceding it. On Monday Messrs. Blair and Co., Stockton, granted it, and to-day (Wednesday) Messrs. Hopkins, Gilkes, and Co., Middlesbrough, have granted it.

MACKIE'S TYPE-COMPOSING MACHINE.—The *London, Provincial, and Colonial Press News*, describes as follows the new perforating arrangement now employed by Mr. Mackie in connexion with his very ingenious type-composing machine lately described in our columns: "The perforating arrangements alluded to are, we believe, those described in the last *Press News*. Each workman has a case not unlike those at present in use, divided into as many boxes as he can conveniently remember. These boxes contain pieces of brass rule, like advertisement rules, notched on both sides. One side represents a letter, word, or part of a word. Two or more of them represent long words or even phrases. These the compositor puts into his stick, which, when full, he hands to a lad who, at a perforator driven by steam, passes them over a row of invisible punches at the rate of 450 letters per minute. They thus perforate the paper and are then ready to be put back into their respective boxes, through openings in the back of the rack. This is the work of a lad. Thus the brasses need be but few, as they are constantly being replaced. Each brass being equal to 3½ ordinary letters, picked up by both *ends*, and most of the words spelt and ready to hand, Mr. Mackie expects a man and a boy to perforate a column of the *Times* per hour. The *justification* part is a curious discovery. Mr. Mackie says that in the process of very long experiments on the size and weight of individual types, many of which differ for no reason in the world, he found that one line of type weighed exactly the weight of its fellow lines, irrespective of the number of spaces which either line might contain. He discovered the reason, and has amused many a printer at the late Exhibition by putting a line of en quads into one scale and a line of lower-case matter into the other scale, and showing that there was not over a hair space difference in the weight. The fact is, he says, 'the type-founders use a heavier metal for spaces, and no one has ever tried the weighing process to check them in what smacks of smart practice. Upon this discovery he founds his doctrine of 'justification by weight.' One line is as heavy as another, hence if you make your brasses weigh what letter or word or phrase they are intended to represent, and use a setting-stick which is virtually a pair of scales, you can keep picking up brasses till your scale turns, and change one space for another (i.e., one brass for another), far more rapidly than you can do in hand setting. The ideas involved, like those in Mr. Mackie's composing machine, are novel and original, and, so far as we see, perfectly practical, and they do away with the common bugbears against all composing machines, that they cannot 'justify.' By Mr. Mackie's system, before a single perforation is made, the letters and spaces necessary to make a line of any length are anticipated by the weight of the brasses."

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ENGINEERING.

FRIDAY, OCTOBER 20, 1871.

ROLLING STOCK MAINTENANCE.

ALL who have been in the habit of attempting to gain information concerning the financial condition of a railway company by an inspection of the half-yearly reports must at some time or the other have earnestly wished for some means which would enable them to judge whether the sum set down for the maintenance of the rolling stock was or was not a really sufficient sum for the purpose, or whether a fictitious profit had been obtained by allowing the stock to depreciate below what ought to be its normal condition. It would, of course, be idle to suppose that any method whatever, having for its foundation the inspection of a half-year's accounts, will give to the inquirer *precise* information as to whether the rolling stock of the company has increased or depreciated in value during the half-year to which the accounts relate; but if the company be an important one, having a large number of engines and vehicles, a tolerably correct idea of the state of affairs may be obtained in a very simple way which when fully developed will, we believe, produce valuable results. Of what this method is, and of the facts upon which it is founded, we propose now to speak, our object in doing so being more especially to lead to the collection of such data as will enable it to be more advantageously adopted.

In April, last year, Mr. R. Price Williams read before the Institution of Civil Engineers, a paper "On the Maintenance and Renewal of Railway Rolling Stock." To this paper—which is a monument to the industry and patience of its author—there were appended a series of tables containing a vast amount of most valuable statistical information concerning the detailed cost and maintenance of locomotives and rolling stock, derived from the experience for many years past of our leading railway companies. These tables and the diagrams which illustrate their chief results graphically possess numerous points of interest for railway men; but it is not of these details that we propose to treat here; but only of their bearing on the subject we have mentioned at the commencement of this article. From the extensive data he had collected, Mr. Price Williams deduced the fact that the average money life of an engine might be taken as 10.717 years, and that of a tender as 12.04 years, the "mean money life" of the two combined being 10.91 years. By the term "money life," we should explain, is meant that period in which—if the engine was properly maintained—sums would be spent in repairs and renewals amounting in the aggregate to the total net cost of an engine and tender. This money life being known, and the cost of an engine being also known, it evidently follows that the average annual amount to be spent in keeping such an engine in proper repair becomes known also, and it is in this way that the data contained in Mr. Price Williams's tables become available for examining railway accounts as we shall show presently. It is, of course, evident that, although a knowledge of the mean money life of an engine and tender enables the average annual expenditure necessary to maintain efficiency to be calculated, yet that it gives no idea of the manner in which this average amount is to be divided out between successive years. For this reason the system of checking accounts to which we are referring is only applicable in cases where the amount of rolling stock in use is so large that irregularities of expenditure on individual engines or vehicles become merged in the general average, as is, of course, the case with all our leading railway companies. The same sets of data which enabled Mr. Williams to deduce an average money life also enabled him to fix upon an average first cost for an engine and tender; and this he has taken as 2400*l.* Proceeding in the same way, Mr. Price Williams has, partly from the data contained in the paper to which we have referred, and partly from further data subsequently collected, determined the mean cost and money lives of carriages and wagons, the mean cost of carriages of all kinds being taken by him as 189*l.*, and the mean money life as 8.791 years, while in the case of wagons he has found the mean cost to be 76*l.*, and the mean money life 16.393 years. It must be clearly understood that the term "money life" in all these instances is distinct from the real life of an engine or vehicle, and equally distinct from the average age beyond which the stock of a line should not be allowed to go if it is desired to maintain it in full efficiency. The average age of the rolling stock cannot be determined from ordinary half-yearly accounts, and this fact adds greatly to the value of the plan of which we are speaking.

We should also mention here that the data collected by Mr. Williams included statements of the average running expenses per locomotive per annum incurred on our different leading railways, and these results, which are derived from the accounts of a series of years, he proposes to use in the manner we shall explain directly.

These matters being premised, we may now explain how the facts above mentioned may be turned to account for the purpose of checking railway expenditure, and we can perhaps best do this by considering an example. Let us, for instance, take the expenditure on locomotives and rolling stock for the year 1869 as given in the Board of Trade returns. According to these returns the London and North-Western Company possessed in that year 1549 locomotives, and according to Mr. Williams's figures the sum which should have been expended in repairing and maintaining these engines would be $\frac{1549 \times 2400}{10.91} = 340{,}753l.$ From Mr. Williams's table last mentioned, also, we find the average running expenses per engine per annum on the London and North-Western Railway to be 336.42*l.*, this giving a sum of $336.42 \times 1549 = 521{,}111l.$ for the whole number of engines, and we should thus have $340{,}753 + 521{,}111 = 861{,}864l.$ as the total locomotive expenditure for the year. The amount actually expended was 808,916*l.*, and assuming Mr. Williams's figures to be correct there would thus have been a deficit in the required expenditure of about 53,000*l.* In reality, however, we believe that the calculated requisite expenditure is in this instance materially in excess of that really necessary, and this, for a reason, we shall explain hereafter, but which we need merely mention at present. Turning now to the carriages and wagons we find, from the return previously referred to, that in the year 1869 the London and North-Western Company possessed 3814 vehicles of the former and 28,488 of the latter class. According to Mr. Williams's figures the expenditure necessary to maintain this stock would be:

$$\frac{3814 \times 189}{8.791} + \frac{28{,}488 \times 76}{16.393} =$$

81,997 + 132,075 = 214,072*l.* The amount actually expended on the repair and renewals of carriages and wagons during the year was 275,130*l.*, so that here again was a deficit assuming Mr. Williams's data to be correct. Treated in the same way the returns of the Lancashire and Yorkshire and the South-Eastern Railway Companies for the year 1869 give the following results:

	Calculated necessary expenditure.	Actual expenditure.
Lancashire and Yorkshire:	£	£
Locomotives	272,128 ...	261,335
Carriages and wagons	101,187 ...	76,082
South-Eastern:		
Locomotives	151,578 ...	154,361
Carriages and wagons	54,778 ...	45,210

The examples we have given will, we trust, explain clearly the way in which it is proposed to turn to account a portion of the data which Mr. Williams has collected; and there can be no doubt that the principle upon which the system is founded is a true one. Of course, the practical utility of the plan depends upon the accuracy of the assumed values for the terms "money life" and "average first cost." These values will in reality vary to some extent on different lines worked under different conditions; but a careful examination of the results deduced from the practice of our leading railways shows that in the case of extensive lines under good management this variation is exceedingly small notwithstanding differences in the traffic. The figures adopted by Mr. Price Williams are founded on very extensive data and are, we believe, as reliable as a careful examination of that data can make them; but notwithstanding this they are, of course, subject to correction by experience derived from a still wider range of facts, and we, therefore, do not by any means accept them as final values, but only as the best at present available. There is one point more to which we wish to direct attention, and we may then dismiss this portion of our subject. We have said above that the calculated required expenditure for the London and North-Western Railway for the year 1869 was too high, and we will now explain why we are of this opinion. In calculating the total expenditure the running expenses were obtained by multiplying the number of engines by 336.42*l.*, this latter sum being the average running expenditure per locomotive per annum deduced from the accounts of eleven years. But we consider that in the case of a line like the North-Western where the running expenses have been materially reduced of late years it is erroneous, in estimating the expenditure for any given year, to take as a multiplier a value deduced from a number of years' experience, but that rather that of the year last preceding should be taken. We have not the detailed reports of the London and North-Western Railway for the year 1869 at hand, but we believe that the running expenses per engine for that year would be more nearly 300*l.* than 336.42*l.*, and assuming this to be so the supposed deficit in the expenditure would at once disappear. Of course, really, running expenses have nothing to do with the matter we are dealing with, namely, the maintenance, and it is only necessary to bring them into the question when the *total* necessary locomotive expenditure has to be estimated.

Besides it being desirable that a ready means should be available for checking the expenditure of a railway, it is equally desirable that there should be a mode of judging with some degree of accuracy as to whether a line is or is not sufficiently stocked. In fact, if this cannot be done, the calculations as to the expenditure on maintenance become useless in determining the financial position of the line. Unfortunately, precise data as to the value of the stock in use on successfully worked lines, with different amounts of traffic, are available to but a very small extent; but on the other hand there is an old axiom amongst railway men which appears to afford assistance in the difficulty of deciding what the value on any line should be. This axiom is to the effect that, the capital expended in rolling stock, should equal the traffic receipts for one year, and curiously enough it gives results closely agreeing with good

practice. Thus, if we take the Board of Trade returns for 1869, and work out from them the capital expended in stock—assuming the first cost of the engines and vehicles to be those determined by Mr. Price Williams—we get, in the case of three of the leading lines, the following results:

		£		£
London and North-Western:				
1,549 locomotives	×	2400	=	3,717,600
9,814 carriages	×	189	=	720,846
28,485 wagons	×	76	=	2,165,088
Total estimated cost			...	6,603,534
Traffic receipts for the year			...	6,682,251
Lancashire and Yorkshire:				
477 locomotives	×	2400	=	1,144,800
1,704 carriages	×	189	=	322,056
13,913 wagons	×	76	=	1,057,388
Total estimated cost			...	2,524,244
Traffic receipts for the year			...	2,553,293
South-Eastern:				
243 locomotives	×	2400	=	583,200
1,763 carriages	×	189	=	333,207
3,641 wagons	×	76	=	276,616
Total estimated cost			...	1,193,023
Traffic receipts for the year			...	1,554,436

The agreement between these estimated costs of rolling stock, and the annual receipts, is, in the case of the London and North-Western and Lancashire and Yorkshire Railways, very striking, while when it is remembered that at the date to which these figures refer, the South-Eastern was generally regarded as an understocked line, the difference in the case of that railway is readily explained. Why this relation should exist between the annual receipts and first cost of rolling stock, it is difficult to explain, but that it does exist appears tolerably certain, and there are many cases to which a knowledge of its existence may be useful.

INDIAN ENGINEERING AND INDIAN RIVERS.

One of the greatest difficulties that has beset our engineers in India has ever been the uncertainty of the rivers. Sometimes this uncertainty has been with reference to the river channel which, in certain cases, is liable to change its course from time to time, and instances have been known of a bridge which once spanned a river bed, being left high and dry, whilst the river, divesting itself of the encumbrance, ran freely past it on one side. But a more serious, and also a more common danger to engineers and their works is the occasional occurrence of exceptional floods of irresistible force—which, finding too little waterway allowed for their swollen torrents, breach embankments, and carry away bridges as though they had been things of straw. For such events the engineer is not always to blame. There are, in most cases, no records in existence relative to the height of floods in certain rivers extending back to any great distance, and in such instances it is the usual custom to make inquiries of "the oldest inhabitant" living in the neighbourhood of a proposed bridge, as to the level of the highest known flood, which is generally remembered by the fact that on one occasion the water reached the door sill of a certain hut, or extended to such a distance beyond a certain landmark, but beyond such questionable authorities there is little left to guide him in this most important investigation, and he has accordingly to make the best of such "proofs," and to make such provision for waterway as may seem necessary to meet the requirements of probable extreme floods of the future. After the construction of such works, however, improvements in the upper beds of a channel, and the removal of obstructions, may cause such increased facilities for the flow of floods as seriously to compromise any works lower down stream, and even the clearance of forest may, by removing one of the barriers imposed by Nature for preventing the too rapid flow of excessive rainfall on the catchment basin of a stream, into the natural drainage channel, cause such a disturbance of the relative proportions of river-bed to the drainage area, as to stultify all previous calculations relative to the flow of water which it may be called upon to accommodate. Owing to the so-called "unprecedented" rains of this year in the Punjab, most disastrous effects have been produced upon some of the works on the Punjab and Delhi Railway, and as this is a subject which, above all others, perhaps, is most important to be considered in the construction of river works in India, we have thought it desirable to draw prominent attention to it on the present occasion, and, in doing so, it is not with any desire to reflect upon the want of forethought on the part of the engineers of that railway, but rather to draw special attention to a fact which, though now well known, is perhaps not sufficiently thought of and allowed for in the construction of those works, which must ever prove the weakest points of a railway, especially in India, namely, the bridging of rivers.

From Delhi to Moultan the railway passes over a country almost perfectly level, the exceptions being an almost imperceptible rise in the ground between the rivers, and the low broad beds of the rivers themselves. Between Delhi and Lahore the line crosses three great rivers, the Jumna, the Sutledge, and the Beas, besides a great number of smaller rivers, such as the Gugger, the Tengri, the Kalee Nuddee, and several large canals. Over the level country the railway is carried on a raised embankment, here and there pierced with culverts to give waterway to the periodical floods, and this embankment runs directly across the natural runs of the drainage. The embankment thus acts as a great dam, and when rain falls in too great quantities to admit of being carried off by the river beds, or the culverts, the country becomes flooded, and the surplus water is heaped up on one side of the dam, which must inevitably give way if it be not strong enough to resist the enormous weight, or become breached should the water at any one point overtop the summit of the embankment, or the culverts may be blown up by the force of the water, resulting in either case in the destruction of a portion of the railway. The flooding of a considerable tract of country may also, besides the destructive consequences above named, be followed by evils not less to be dreaded upon the subsidence of the waters, namely, such as arise from malarious exhalations. And it is not altogether unreasonable to suppose that the complaints on these grounds, raised by the natives in Lower Bengal some time back, may have had good foundation. They pointed out the injurious effects caused to the surrounding country, from a sanitary point of view, by the embankments of the East Indian Railway, which, they asserted, by interfering with the proper drainage of the country, caused an increase of swamps and their usual malarious effects. Across the rivers the Punjab Railway is carried by means of girder bridges built upon piers, the piers being sunk on single wells. The Punjab rivers are noted for the shifting character of their course, and sometimes, without any apparent reason, a river will suddenly begin to bear against some particular point, and in the course of one season change its bed to the distance of perhaps several miles. Bridging these shifting rivers, therefore, is a difficult task, involving also, as it does, the responsibility of selecting some spot where, from local circumstances, such a deviation of channel is not possible to occur. Such immense bridges as those over the Sutledge and Beas may fairly be considered as great engineering triumphs, having been constructed in spite of great natural difficulties, one of the chief of which was the obtaining of a solid foundation for the piers; for on sinking to a certain depth in the river bed, quicksands of a peculiarly shifting nature were invariably encountered. Indeed, it is stated in a recent local report, that underneath the bed of every Punjab river there is an underground river of water and sand corresponding to the course of the external river.

The foregoing particulars and considerations will, in some measure, assist in accounting for the serious failures which have recently taken place on this railway upon the occurrence of an unusually high flood. The disaster itself, also, will not be an unmixed evil; for failures of great engineering works, not arising from the use of inferior materials in construction, or from recognised errors in design, are often the dearly bought experience which ultimately leads to improved knowledge; and although such a method of obtaining knowledge is to be deprecated, it is nevertheless through accidents and fortuitous circumstances that many great discoveries and inventions have been made. Instead, therefore, of merely lamenting over a serious accident, or endeavouring to discover who shall be hung, the searcher after knowledge and truth will always endeavour to turn the occurrence to his advantage, and by making a faithful examination into the cause, learn how to avoid similar catastrophes for the future. Let us hope that the present lesson will not be altogether lost on the railway engineers in India, and that the numerous State lines, which have been so long talked about, if ever they are really commenced, and actually prosecuted to completion, may be found provided with every safeguard against accidents from floods, and other natural causes, which the experience of the past has proved to fall, as a rule, to the common lot of such works in India. To return to the recent accident on the Punjab and Delhi line. From accounts from India it would appear that the floods of the past season have not only damaged the embankments of this line, but the bridges have also suffered to such an extent that the traffic is virtually stopped, and it remains yet to ascertain the length of time and amount of expenditure that will be required to be expended before the line can be put again into proper working order. Amongst other calamities, the Beas bridge is broken. One pier has sunk, carrying with it the girders on each side. The defence wall, built to protect the junction of the bridge with the ordinary embankment, has been broken down, and a huge gap made in the embankment, through which the river is now rushing, as if in a new channel, over the engine which lately sunk into the gap. This, it is supposed, was caused by one of those circumstances referred to above, as being common to some of the Punjab rivers; and the river Beas, in seeking a new course towards the east, and so unduly pressing against that side abutment, caused the accident which we have now to record. The pressure in that direction appears also not to have slackened since the occurrence of the mishap, and now the embankment has been so damaged between the bank of the river and the Kurtarpore station, nine miles off, that traffic has been stopped. Between Kurtarpore and Phillour, on the banks of the Sutledge, the pressure of water has not been so great upon the embankment, but the bridge across the Sutledge is considered doubtful, and no trains are permitted at present to run over it. The eastern side of the Sutledge has been damaged, and the embankment is said to show signs of giving way. At Rajpoora the embankment has received some damage, and the bridge over the Gugger is broken. The rail is carried over this river by a girder bridge on piers, like the other great bridges. One of the piers has given way, and falling on the down stream direction, carried with it the span girders on each side. There had been exceedingly heavy rain during the night, causing the Gugger to rise sixteen inches, the force of which proved more than the bridge was able to withstand. Between Umballah and Sirsawa, the embankment is much damaged, and it is reported that one or two bridges over the smaller rivers have either given way, or are showing signs of weakness.

Such is the list of disasters caused to a single line of railway by a single flood, so far as the record of them has at present reached us. Of course there will be the usual commission appointed to examine into the cause of this calamity, and we shall look forward with considerable interest to the appearance of their report, which, it is to be hoped, will not be confined to a mere narration of the fact that an unusually high flood caused an unusual amount of damage to the railway, for which no one can be held responsible; but that some useful deductions may be drawn from the circumstances of the case, which may prove instructive to engineers generally, and especially to those who may be engaged upon the preparation of designs for future railways, or for the execution of such works as will be required for the repair of the line in question.

FRENCH RAILWAYS.

The war between Germany and France, of course, told severely upon the railway interests of the latter country, especially upon the Eastern of France, the Northern of France, and the Western of France systems. The Paris, Lyons, and Mediterranean and the Orleans Railways also suffered, but to a less extent. As an illustration of the disasters resulting from the conflict, we may detail some of the "experiences" of the Western of France Company during the autumn and winter of 1870 and the spring of 1871. Before hostilities commenced the directors had hoped to profit from the favourable rate at which they expected to issue the obligations of the company, and to communicate accordingly some additional activity to the construction of new lines conceded, but still unexecuted. With this object, they had submitted a series of plans for the

examination of the Governmental authorities, and the greater part of these designs had received ministerial approval. Arrangements were made accordingly to proceed with the execution of some of the plans, but as soon as the war broke out, and even before the council of administration entertained any apprehensions as to the disasters which the struggle brought upon France, it was deemed advisable to check or suspend all construction expenditure. The council accordingly rigorously adjourned the execution of all projects, however useful they might be, which had not been actually undertaken. As regards lines already commenced, the directors also completely suspended the works wherever it was possible to do so without incurring the risk of legal proceedings on the part of persons interested. The result of the policy adopted was that while the outlay originally contemplated for the construction of new works in 1870 was 2,240,000*l.*, the actual expenditure made did not exceed 871,416*l.* The same cautious policy is being enforced as regards the current year, although, as month after month of continued peace rolls on, the tendency to a revival of enterprise naturally becomes stronger. The directors have, however, been obliged to put forth all their energies, in the first instance, to secure the temporary or definitive repair of the damages occasioned upon the company's system by the war with Germany and the Paris insurrection.

Among the new works carried out last year upon the company's network may first be mentioned the laying of a second set of rails on the line from the Mans to Mézidon, and the construction of a branch to St. Servan quay on the line from Rennes to St. Malo. Workshops at Rennes were extended, and some supplementary works were executed on the Ceinture (left bank), line and its annexes. A line from Argentan to Granville was completed and opened for traffic in July, 1870, the date previously indicated as the period of its probable execution. A section from Gisors to Gournay was opened in July, 1870. The works of a section from Gournay to Forges, and of another from Forges to Neufchâtel were also actively pushed forward until August, 1870; and, notwithstanding their suspension for some time after that month, they are now nearly completed. The works had, indeed, reached such an advanced stage at the period of their suspension that it was deemed advisable, on the close of the war and the insurrection in Paris, to finish them off as soon as possible. Traffic is accordingly expected to be commenced either towards the close of 1871 or the first few months of 1872 upon the whole distance between Gournay and Neufchâtel. The directors have deemed it advisable to postpone the works of the section from Flers to Mayenne, but they have continued at a slackened rate those undertaken between Caen and Flers, or, to speak more exactly, between Caen and Berjou-Pont-d'Ouilly, since the section from Berjou-Pont-d'Ouilly to Flers has been opened for traffic for some time. The construction of the Gouttes tunnel, the difficulties of which are considerable, has been proceeding in a satisfactory manner, and everything leads to the anticipation that the work will be completed within the time and at the cost originally estimated. Upon the Napoléonville and St. Brieuc line the section from St. Brieuc to Quintin is expected to be opened for traffic towards the close of the year, while the remaining section from Quintin to Napoléonville will be completed in the course of 1872. The expenditure of 871,416*l.*, already indicated as having been incurred for new works last year, includes also the outlay made for additional rolling stock.

To turn now to the direct damages inflicted upon the company's system, first, by the war with Germany, and then by the Parisian insurrection, it may be remarked that the Batignolles stations and workshops were greatly injured by the second unhappy struggle. Artillery combats were carried on for nearly a month between Batignolles, Montmartre, and Asnières, and caused much damage both to way and works. The roofs of the carriage sheds and workshops received numerous shells, and a great quantity of glass was broken. The Auteuil line and the Ceinture line (left bank) were little affected by the fire of the Prussians, but the damage occasioned by the civil war was of more importance. The Porte-Maillot station was completely destroyed, and a tunnel near the station was injured. The principal building of the Auteuil station, the great covered hall, and the accessory fittings were entirely destroyed; a large number of rails were also broken. The iron bridge near the Auteuil station was rendered useless by projectiles, and by the rupture of the columns forming the intermediate supports of the road-bed, so that it has been necessary to undertake the reconstruction of the whole work. The Auteuil viaduct was much damaged; none of the arches were broken down, but at several points the piers and some of the arches were sufficiently injured to prevent the circulation of trains without extensive repairs being undertaken. The injuries inflicted on the Point-du-Jour viaduct were somewhat less serious. The Grenelle station was much damaged; the building devoted to offices at this station was also burnt and completely destroyed. Other injuries of less importance have had to be made good on the Ceinture line (left bank). The other suburban lines of the company experienced great injuries during the late conflicts. The bridge over the Seine at Argenteuil, at the entrance of the Argenteuil station, was mined by the French military engineers and completely destroyed, although the remaining portion of the piers may be utilised for the reconstruction of the work. The Argenteuil bridge which comprised five iron arches put the company's St. Lazare terminus in communication with the Northern line *viâ* Ermont; it also served for the passage of trains running on to the second Dieppe line. The Chatou and Croissy bridges over the Seine, and situated on the St. Germain line between the Rueil and Chatou stations were mined by the French military engineers, and five arches out of six as well as two piers and an abutment were destroyed. As it was deemed very desirable to promptly re-establish the train service on this part of the St. Germain line, the council of administration has constructed temporary wooden bridges, the duration of which will, it is expected, admit of the definitive re-construction of the destroyed works being postponed for some years. The temporary bridges were brought into use before the close of the summer. The permanent way of the St. Germain line had been destroyed for a distance of 1½ miles between St. Germain and the Pecq. In consequence of the destruction of the bridge route, both Germans and French utilised this length of 1½ miles as an ordinary road, and it has been necessary since the conclusion of peace to thoroughly clear and repair it. The St. Cloud pleasure station was burnt by the German troops, and the principal passenger building of the Argenteuil station shared the same fate. At the close of the war, the Asnières station no longer existed, and the Clichy-Levallois station had also been considerably injured by shells. The Asnières bridge, often threatened during the German war, was mined by the Parisian insurgents, who attempted to blow it up by means of powder introduced into some of the tubes occurring in the work. This act of savagery happily did not prove completely successful; nevertheless, the span nearest Paris was much injured, and it has been found necessary to temporarily strengthen it, so as to admit of the passage of trains until definitive repairs can be executed. The Couronnes bridge had two columns broken, and its road-bed was much injured by shells. The Bois-de-Colombes workshop and permanent way depôt suffered considerably from the fire of the insurgents. The offices were almost entirely destroyed; the sheds, the chimney of the fixed engine, as well as a great quantity of apparatus and materials were also greatly damaged. We cannot continue at present the dismal recapitulation of ruin inflicted and injury sustained by the Western of France; if we are to do so, and to extend our review also to the other systems which suffered from the terrible strife, from which France has now happily emerged, we must devote further articles to the subject, since it is of vast extent.

SOUTH AMERICAN METEOROLOGY.

Under the title of "Contributions to our Knowledge of the Meteorology of Cape Horn and the West Coast of South America," a very important amount of information has just been given to the public by the Meteorological Committee, especially valuable to navigators in those regions, and calculated to be of great service in unfolding the aspect of oceanic meteorology generally. Several important alterations will be rendered necessary in the text-books of meteorology and also of physical geography, as well as in the sailing directories which treat of these regions, as regards the winds, barometric pressure, temperature of the air and of the sea, and the peculiarities of the weather there. The work is published at the public expense, and is therefore available to all who choose to turn its information to practical account. We propose to place before our readers an outline of the general results, such information, in fact, as must be interesting and valuable to the general reader. Those who require to examine the facts and figures in detail must of course consult the work itself. It consists of monthly charts, on Mercator's projection, on which are plotted the averages of the instrumental observations; diagrammatical charts of the less exact observations, made by eye, of the weather; monthly summaries of the information yielded by the charts and diagrams, together with results of observations made at certain stations within the area to which the charts refer. These additional data are valuable, because they illustrate the climate of Punta Arénas, Puerto Moutt, Valdivia, Santiago, Valparaiso, Copiapo, and Coquimbo. With the exception of Valparaiso, where the observations were chiefly made on board H.M.S Nereus, the local information is given on the authority of Dr. J. Hann, of Vienna, having been converted to English measures from the *Journal of the Austrian Meteorological Society*.

The collection of the information contained in these charts was commenced under the direction of the late Admiral Fitzroy. The Meteorological Committee did not consider it advisable to continue the collection upon the plan adopted, but, being desirous of turning what had been done to good account, directed it to be prepared for publication. The observations are of very good quality, but insufficient as regards quantity; it has, therefore, been an object to give this amount in such form that it may be used in combination with other data when available. The method employed for charting the data has been devised by Captain H. Toynbee, and it is hoped that it will prove acceptable to navigators, whose requirements are the first consideration of the office.

The area embraced by the charts extends from the equator to 60 deg. S. latitude, and from longitude 60 deg. to 100 deg. W. It is divided into sections of 5 deg. latitude and 5 deg. longitude, in each of which is drawn a circular diagram radiated for points of the compass, having outer spaces for the number of times the wind has been recorded from each direction, and inner spaces for the mean force of the wind for each direction. In each section the top left-hand corner contains the total number of wind observations, under it the number of variables with their mean force, and under them the number of calms. In the top right-hand corner are the number of observations and the mean height of the barometer. The lower right-hand corner contains the mean air and sea temperatures with the number of observations written above them. In the lower left-hand corner is entered the times of rain in the number of notations made of the weather written above it. In the sections where there are no data, blank diagrams have been given, so that the navigator may, if he wishes, fill them in with his own observations to serve for his future guidance. Thus we have a perfect record—now comes the picture. An arrow, flying with the wind, of which there is the largest number of observations, is drawn through the centre of the innermost circle of each diagram, unless a quarter of the whole of the wind observations in the section have been calms, then that circle is shaded, if variables "v'bles" is entered. Finally, isobaric and isothermal lines are drawn over the chart, on the assumption that the centre of each section represents the position of its mean pressure and temperature. Thus we have but to glance at the chart to know what the average pressure, temperature, and wind in any part of it may be, while if we require more minute information the figures are there for consideration. The hours at which the observations which have been used have been taken are usually 4 a.m., noon, and 8 p.m. Whenever observations at these hours were not available, the hours have been chosen which would give the best attainable mean for the day. All instrumental readings have been made with verified instruments duly corrected.

As regards the number of observations, we should inquire, at the outset, whether they are sufficiently numerous to afford good average values for the respective meteorological elements. Less than ten years' observations are, we believe, considered insufficient for meteorological averages anywhere in extra-tropical latitudes. Hence with

three sets of observations daily, the total number of sets required for each square for each month would be about 900. A cursory examination of the charts shows that in no instance have the averages anything like this weight. The greatest number of observations is 135 in a section south of Cape Horn in June. Allowing three observations daily this represents only 44 days. Hence the averages for this part of the ocean are derived from an insufficient number of sets of observations. They are also defective, because the sets are frequently incomplete; either the barometer has been recorded more frequently than the wind, or the thermometers have not been read, or the weather has not been noted. If we have any faith in the correlation of the meteorological elements, to trace their laws by values it would seem to be necessary to employ complete sets of observations. Hence these data should be regarded as instalments, to be added to at a future time, and not as reliable settled averages. As the number of observations is not only insufficient, but variable from section to section, while some sections are not represented at all in some months, it is out of the question to seek for annual averages, and they have not been attempted. Notwithstanding the want of data in some sections, and the low numerical value of the averages in others, these charts exhibit the meteorological phenomena in a manner that has never before been equalled. Indeed, it could hardly be expected that a larger mass of observations would materially modify the broad general results. Some of these we proceed to state. The atmospheric pressure, all the year round, is lowest in the high latitudes, increases rapidly to the 40th parallel, and thence decreases very gently to the equator. A closer inspection reveals a maximum pressure every month, though not to an equal extent in all, and scarcely perceptible in June, somewhere between 22 and 42 deg. S., and 82 to 97 deg. W., the mean position being about 33 deg. S., 91 deg. W., decreasing towards the land. In connexion with this area of high pressure, it is an interesting fact that the temperature is considerably higher over the district where it is observed than it is near the coast. This is a peculiarity, because we usually find cold associated with high pressure, and warmth with low pressure.

A cursory inspection of the isobars, isotherms, and wind arrows, gives a good idea of the relation between pressure, temperature, and wind. The divergence of the isobars in about 40 to 45 deg. S., part running to the north, whilst others run east, or even south-east, with a corresponding divergence of the wind, is very instructive. The wind seems to draw round the coast of Patagonia, for the wind arrows indicate a more northerly direction on its west coast, more westerly on its south, and more southerly on its east coast. The arrows drawn upon the charts represent the prevalent winds. Generally they represent the current of air as flowing between the isobars conformably to the law of wind in relation to pressure in the southern hemisphere. Where the isobars are closest the winds are strongest, and where they diverge from each other light breezes are usually reported. Patches of high pressure seem to be frequently accompanied with light airs and calms. An irregular course of the isobars is generally indicative of atmospheric disturbance or of variable winds.

From the equator to 40 deg. S. there is a considerable difference between the temperature on the coast, and that on the sea in longitude 100 deg. W. "The question arises, what produces this difference between the littoral and oceanic climate? The cause has hitherto been assigned to the cold water of the oceanic current, discovered by Humboldt, which is said to exist off the coasts of Chili and Peru, and to transport the waters of latitude 50 deg. into the equatorial westerly drift. The observations of the temperature of the surface water contained in these charts do not appear to give much support to this hypothesis, since the sea here is almost always warmer than the air. The current may be an auxiliary cause, though we have not the means before us to investigate the matter; but the principal cause seems to be the prevalent southerly wind. From latitude 40 deg. S., sometimes from 45 deg. S., or much farther, a southerly wind generally blows along the coast, and eventually turns into the S.E. trade, after passing by the area of highest pressure. This wind only fails in July and August, which are precisely the months in which the isotherms of the middle latitudes are the least deflected northward. It seems, therefore, probable that the general deflection of the isotherms northward, or, in other words, the cool temperature of the coast is brought about by this southerly wind, which transfers the air of the temperate zone to the tropics." "The southerly wind begins to fail in June, during which month, as well as in July and August, the atmospheric pressure off the coast is nearly similar to that over the ocean to the westward. From March to August the trade wind extends only to 25 deg. S., during the rest of the year it reaches 30 deg. S." Between 50 and 60 deg. S., and 50 to 70 deg. W., kelp or other sea-weed is frequently reported, and in these latitudes both the air and sea are generally cooler to the eastward than to the westward of 75 deg. W.

In the summer the sea off Cape Horn seems to be cooler than the air, while in the winter the condition is reversed.

Rain is remarkably frequent in the high latitudes, and the excessive amount of aqueous vapour always there may account for the prevalent low pressure. An examination of the weather notations leads to the inference that the sky is always more clouded in the high latitudes than in the tropics. Fogs are frequent in the vicinity of Patagonia and the Falkland Islands, and mist seems to be more generally met with near the land than out at sea. Squally weather is most encountered in the high latitudes, but very seldom in the trades, where rain is also rare.

We do not know that a better method has ever been proposed for utilising observations on the amount of cloud than is adopted in this work. The state of the sky, as distinguished from the state of the lower air, which is affected by mist and fog, is given in the diagrams in two ways—(1) by the terms clear, cloudy, overcast, showing the number of times these conditions were noted by the observers; (2) by the tenths of the sky estimated to be covered by clouds, the average of the observers' estimates being given in each section of each chart. We have thus a double means of forming an idea of the comparative conditions of cloudiness or clear sky, from which the relative proportion of sunshine may be roughly estimated. No means are available for the registration of sunshine, and where facts cannot be established a good guess is worth having. The results are all founded upon guesses at the amount of cloud. They teach us something, and, therefore, cannot be dispensed with.

The notations of lightning are only about 4 per cent. of the total number of weather observations in which it occurred. These were well distributed between the parallels of 25 and 60 deg. S. in the different months, excepting in January, in which month no lightning was recorded. In the trade wind region, from 25 deg. S. to the equator, there was no lightning recorded.

The neighbourhood of Cape Horn has a climate which scarcely varies in mean temperature from 35 to 45 deg. throughout the year; the barometer fluctuates from 30.603 to 27.662 in., though its mean value is about 29.5 in.; rain or snow in winter fall almost every other day; an overcast sky is the rule, a blue sky the exception, and with prevalent strong westerly winds, squalls and gales are frequent. The inclemency of the climate is aggravated by the long continuous gales accompanied with snow or hail, and the fury of the biting squalls terrible and devastating in their strength. The billows, which are at all times more turbulent here than in other regions, are lashed by the gales into tremendous waves capable of sweeping everything before them, the fierce squalls cutting off their crests and scattering the water in blinding sheets of spray. The ships' decks are flooded; weeks may elapse before there is a dry spot upon them; and the sailors live almost as much in the water as the porpoises which here abound. If gales of rain, hail, or snow do not numb the energies of the mariner, which in these seas are more than ever required, dark and gloomy weather prevails, with dense clouds or fog obscuring the sun, moon, and stars, and leaves him without celestial observations for days and days in succession. If bound eastward, the predominant west winds soon bring him through this inhospitable region; while, if bound westward, he must buffet against them. In June or midwinter, fortunately, there is the best chance of meeting with easterly winds.

We strongly recommend these charts to the careful study of navigators and meteorologists. The work is superior to anything yet produced by the Meteorological Office. It would be immensely valuable to commerce and science to have similar charts for the entire ocean. There is no reason why we should not. There are data accumulated in the Meteorological Office over and over again exceeding in numerical value that now published, and it might be worked up systematically and rapidly on this plan. The Meteorological Committee are, we fear, frittering away the time and their means in working up the data on an excessively minute division of area, and at the present rate of progress a generation or two may pass away before the results can be published. We urgently ask for results as soon as possible; indeed, with the utmost speed of reduction, and at whatever cost, on the present plan. We shall then be able to judge whether or no it is expedient to go into more minutiæ or subdivision of area, and meanwhile we should have a vast mass of information available for the practical purposes of navigators, and the scientific labours of meteorologists and philosophers. Science even then may not be satisfied, but practice will be equipped with better arms wherewith to fence the perils of the sea.

NOTES FROM PARIS.

Paris, Oct. 16, 1871.

The Water Supply of Nimes.

M. Dumont, an engineer who, in 1853, successfully accomplished some difficult works in raising the water of the Rhône to the heights of Fourvières and of Croix-Rousse, has just completed a new hydraulic work, which presented great difficulties. The waters of the Rhône were, on the 9th of September, led into the reservoir of Nimes. The water is drawn from the river at Comps into a filtering gallery, about 1600 ft. long, and of 39 ft. 4 in. opening. The discharge from this gallery is ample, and there is every reason to suppose that it will operate as satisfactorily as the one constructed at Lyons, 980 ft. long and 32 ft. 9 in. wide, under the same conditions. The filtration during the times of lowest water in the Rhône is abundant. So soon as the engines were started, the water in the gallery fell from 15 to 19 in., after which the level remained unalterable, because the filtration which this change of level induced, through the gravel in which the gallery has been pierced, was sufficient to compensate for the quantity raised by the engines. The inflow of the water into the gallery was very slow, thanks to the great size adopted, and there was no tendency to undermine the abutments of the wall at any point. The water leaves its impurities, held in suspension, on the top layer of gravel, which forms the bed of the river, and the cleansing of the filter is naturally maintained by the waters of the Rhône, the bottom of which is subject to alteration due to the times of flood. The gallery, which can be navigated with ease, was pierced and stone-lined during the season of lowest water, and without any of those accidents so common and so costly in hydraulic works.

Two engines, each of 200 horse power, constructed at Creuzot, draw the water through a distance of nearly six miles, and to a height of 216 ft., and each give a daily duty of 3,310,000 gallons of filtered water. This quantity is amply sufficient for the requirements of the town, so that one engine is only worked at a time. There remains, however, to give to Nimes the full value of the supply, by constructing the necessary conduits, and laying down mains for the distribution of the water.

Lequesne's Commutator.

The elements of an electric pile can be grouped according to three classes, that of tension, of quantity, and of series. When with the same battery successively different effects are produced, or when the action lasts long enough to show a sensible decrease of energy, the groupings of the elements can be changed according to the variations of power or of resistance. The change involves a marked loss of time when it is necessary to produce it by manœuvring the wires of the electrodes. But one can obtain the commutations for obtaining various groupings by the simple movement of a handle. M. Lequesne is the inventor of a commutator of this kind, and M. le Comte du Moncel states in his report to the *Société d'encouragement* that it is more complete and more efficient than the similar apparatus already in use. M. Lequesne gives to his special commutator the name of Voltamétreiste. It is composed essentially of a cylinder, to the surface of which is applied a series of metallic plates, divided up in a particular manner with regard to the various systems of groupings of the battery, and of two systems of rubbing plates bearing on the cylinder, and in contact with the divided plates, and two different generators.

The one of this series is directly in connexion by wires with the positive poles of the different elements of the battery, the other with the negative poles, and it is only necessary to turn the cylinder in such a manner to place under the rubbing plates such combinations of the divided plates to obtain immediately the desired grouping of the battery.

To obtain the element of quantity in the battery it will be sufficient to bring under the two series of rubbing plates two continuous metallic plates of a length equal to that of the two series of rubbers. The battery will then work as if it were composed of a single element, with a surface equal to that of the whole of the elements.

To add all the elements in tension, it is necessary to have a number of metallic plates equal to half the number of the elements of the battery, all ranged on the same generator of the cylinder, and of a width sufficient for the plates of the two series to be applied simultaneously two by two.

Lastly, to obtain a series, that is to say, to obtain from a battery of 24 elements the current which should give for example a battery of 8 elements of threefold the surface, it is necessary that the divided plates alternate from the one to the other series of rubbers as many times as there are the series of elements, for instance, eight times in the example given above.

M. Lequesne constructs the apparatus for 24 elements, and combines them together when he operates with batteries of a greater number of elements. He places in his cylinder eight series of plates, permitting eight groupings by series, that form a battery of 24 couples.

CHAMELEON BAROMETER.

M. Lenoir, an inventor as fertile as ingenious, and who is especially known by the gas engine that bears his name, and by a system of autographic telegraphy, has just introduced a kind of barometer which at least has the merit of ingenuity. It is composed of a dial, in the centre of which is traced a circle, the diameter of which is almost half that of the dial. The annular space comprised between the two circumferences is divided into four sections; on the lower one is inscribed the name of the inventor and that of the apparatus, "*baromètre caméléon*," the compartment to the left is pink, and bears the inscription "much rain," the top one is grey, with the word "variable," and that on the right greenish-blue, with the words "set fair." The paper in the centre circle changes colour according to the state of the atmosphere, conforming to the tint of one or other of the three coloured compartments, according as it may be very damp, tolerably dry, or extremely dry. The apparatus is, in fact, more a hygrometer than a barometer. The change of colour in the central paper is produced by atmospheric humidity. This sensitive paper is prepared with a mixture of chlorine of cobalt and of marine salts, added to glycerine to attract the humidity.

Salts of cobalt, nickel, copper, &c., are largely employed in the production of sympathetic inks, with which writing or drawings can be made invisible at ordinary temperatures, but which are made visible under a slight heat, and which disappear when the temperature falls.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

New Works near Sheffield.—It is stated on the best authority, that Messrs. Charles Cammell and Co. (Limited), of the Cyclops Works, Sheffield, have bought a large piece of land, some acres in extent, at Heeley, near Sheffield, where they intend to erect iron and steel works at once. These works will stand very advantageously, are close to the Midland Railway main lines, and are just outside the boundary line of the borough of Sheffield. The same boundary also divides the counties of Yorkshire and Derbyshire, so that, if carried out, there will doubtless be an immense saving in rates, which are heavy in Sheffield. Extensive new iron and steel works are being built at Carbrook, Sheffield, by H. G. Brown, and will, when completed, prove an important addition to the producing power of that town and district.

New Railway Station.—The Manchester, Sheffield, and Lincolnshire Railway have opened a station at Attercliffe, near Sheffield, for the better accommodation of the increasing passenger traffic of that district.

Rumoured Railway Extension from Sheffield to Manchester.—It is rumoured, and with some semblance of authority, that a scheme is projected to construct a line of railway from a point near the Broadway tunnel on the Midland line between Sheffield and Chesterfield to the Hassop Station on the Manchester, Buxton, and Derby Railway. It is alleged that an application to Parliament to carry out this project will be made in the ensuing session. The advantages of the proposed line would be to shorten the distance between Sheffield and Manchester, and thus enable the Midland to compete with the Manchester, Sheffield, and Lincolnshire and Great Northern for a share of the Manchester and Sheffield traffic. I am, however, disposed to think that the engineering difficulties and the determined opposition of the many landowners on the route will prove sufficient to give the scheme a speedy *quietus*.

Additional Blast Furnaces at Staveley.—The Staveley Iron and Coal Company (Limited) have just blown in another large blast furnace at their already extensive works, making five furnaces now in blast, and a sixth on the point of completion. These will very materially augment the producing powers of the works.

Another Projected Railway Extension.—The Manchester, Sheffield, and Lincolnshire Railway Company have just concluded a survey for a proposed line from the Kiveton Park station on their line to Chesterfield. This scheme is stated to be backed by the Great Northern Company, and the line, if constructed, would pass through a very rich mineral district, and would prove a sharp thorn in the side of the Midland, who at present monopolise the district. As a matter of course, the Midland will most strenuously oppose the project when it comes before the parliamentary committee.

Main Drainage and Sewage of Sheffield.—The Sheffield Local Board are about to construct several miles of intercepting sewers in that borough, and tenders are now being advertised for. It is also proposed to adopt in a portion of the town the A B C system of sewage in order to ascertain its value, and also to prove whether it is practicable to use it throughout the whole town.

Utilisation of Sewage at Bradford.—The Corporation of Bradford are about to construct the necessary works and buildings required by the Peat Engineering and Sewage Filtration Company for defecating the sewage of the borough. The works will include depositing and filtering tanks, and the building will be constructed with wrought-iron roofing. The supporting columns and girders will be of cast iron. Messrs. Barry and Sons, of Liverpool, are the engineers for these works.

Halifax Corporation Water Works.—A tunnel 825 yards in length, and 5 ft. 3 in. by 5 ft., is shortly to be constructed by the Halifax Corporation about six miles from Hebden Bridge. A shaft about 35 yards deep is also to be sunk between Walshaw Dean and Widdop Water near the Ridge Inn.

Extension of the North-Eastern Railway System.—Tenders are advertised for the construction of the Leeds and Wetherby lines, which will be about 10 miles in length. The line commences near the Cross Gate Station on the Leeds and Selby branch and terminates near the Wetherby Station on the Church Fenton and Harrogate branch.

Tonnage of Coal from South Yorkshire to London.—Both the Midland and Great Northern have carried an increased tonnage during the past quarter. The silkstone coal seems to be a great favourite in the metropolis. During the half year ending September 30th, the Great Northern carried to London 41,324 tons of this coal alone, and there is also a very large increase in the Barnsley coal. Nine of the principal colliers in that district sent no less than 45,552 tons, as against 22,201 tons in the same period of 1870.

State of Trade in South Yorkshire.—The heavy iron trades of the district are fully employed, all the men at the principal works working overtime or double shifts. The demand for Bessemer steel rails shows no diminution, and there is an excellent inquiry for all kinds of railway materials, such as crossings, tyres (weldless), axles, and the like. The foundries are well employed, orders for water and gas pipes continuing to flow in apace. There is a good inquiry for plates, rods, &c. At Sheffield the larger works are fully occupied on armour plates, gun blocks, and other offensive and defensive warlike equipments. The general trades are all fairly busy, there being an improved inquiry for files and best cutlery. The South Yorkshire steam and house coal trades continue active. No trade disputes of any moment have arisen as yet.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Since this day week the pig-iron market has been somewhat more settled. Prices have fluctuated a little, but trade is on the whole very good. On Thursday last the market became firmer than it had been for two or three days before, and business was done up to 60*s.* 10½*d.* cash, and 61*s.* 2*d.* one month. There was little change on Friday or Monday, and yesterday business was done at 61*s.* and 61*s.* 1½*d.* cash, and 61*s.* 3*d.* to 61*s.* 4½*d.* one month, closing nominally at the higher figures. The market has been strong to-day, 61*s.* 4½*d.* to 61*s.* 6*d.* cash paid, closing sellers at the latter, and buyers at the former price. The shipments of Scotch pig iron continue to keep up well. Last week there was shipped on foreign account, 13,089 tons, coastwise, 4879 tons, total, 17,968 tons. In the corresponding week last year, 14,724 tons. Increase upon the week, 3244 tons. The total shipments for 1871 to date are 658,967 tons, 1870, 506,239 tons, showing the large increase of shipments for this year as compared with the same date last year of 152,728 tons. The imports of Middlesbrough iron into Grangemouth for last week were 1740 tons; same week last year, 640 tons, increase, 1100 tons. The total imports for 1871 are 64,444 tons, for same period last year, 52,584 tons; total increase for 1871, 11,860 tons. Up to this date the stock of iron in Messrs. Connal's store for the month has been reduced to the extent of 2000 tons, and the firm had orders sent in on Monday for 800 tons to be sent out of store. The American and German demand for Scotch pig iron continues to be large, and considerable activity prevails in the way of taking up vessels before the shipping season draws to a close. Prices for makers' iron are still very firm, and in some instances there is a great difficulty in overtaking the orders on hand. Gartsherrie No. 1, and Coltness No. 1, are both quoted at 72*s.*, Summerlees No. 1 at 69*s.*, Glengarnock No. 1 at 68*s.*, Shotts and Langloan at 66*s.*

The Malleable Iron Trade.—Of late there has been less urgency in the demand for the shipbuilding varieties of manufactured iron, owing to the interruption in the shipbuilding operations on the Clyde, which has been due, of course, to the strike and lock-out of the shipwrights. In almost all other cases the activity in the finished iron trade is as brisk as ever.

The Clyde Shipwrights' Strike and Lock-out.—Within the last few days there have been significant signs of the approaching termination of the dispute between the Clyde shipwrights and their employers. When it is mentioned that up to yesterday there had been only one launch on the Clyde this month, it may readily be concluded that the masters were getting into difficulties for want of their shipwrights. The lock-out in the lower parts of the river has never been carried out with the rigidity that was desired by some of the employers; and knowing this fact the Greenock shipwrights were induced to apply on Saturday last to the magistrates of that town to use their best endeavours to bring the dispute to a close. They did so, and on Monday evening a large meeting of the men was held for the purpose of hearing the report of the deputation that waited upon the magistrates. The letter from Messrs. Caird and Co. to the magistrates expressed sympathy with the carpenters who had been locked out, and stated that they would open their works for as many carpenters as they could find employment for. That from Messrs. Steele and Co. to the magistrates stated that while they could not agree to open their gates to the carpenters, they would be happy to see the present unfortunate state of matters brought to an end. It was stated that Messrs. Scott and Co. had not replied to the magistrates' appeal. The meeting agreed that the carpenters who could find work with Messrs. Caird and Co., or in any other yard, should resume work at the same rate as when locked out, viz., an advance of 1*s.* 6*d.* per week. Yesterday morning, several of the men locked out got employment from Messrs. Caird and Co. That firm, however, have all along employed the greater number of their carpenters. The magistrates yesterday received a letter from Messrs. Scott and Co. It was similar in its terms to that of Messrs. Steele and Co.'s, but suggested a reference to the Glasgow Masters' Association. I understand that yesterday afternoon the representatives of the shipwrights in the Glasgow, Govan, and Partick districts were informed by the chairman of the Masters' Association, Mr. Jamieson, of the firm of John Elder and Co., that the employers were prepared to concede the terms requested by the men before the strike broke out. The wages are henceforth to be at the rate of 6*d.* per hour, which will be equal to an advance of about 3*s.* per week. It is considered that the strike is now practically at an end. Considering that so many men have left the Clyde during the strike, and found remunerative work elsewhere, there will doubtless be some difficulty at first in filling the "struck" yards with the requisite number of men, and as a consequence it is not unlikely that men may be tempted to come from Greenock for the higher wages given in Glasgow, Govan, and Partick, and thus, almost of a certainty, the Greenock wages will also be advanced to the same rate.

Proposed New Water Supply for Edinburgh.—At a meeting of the Works Committee of the Edinburgh Water Trust held on Monday, there was submitted what seems to have been an interim report by Mr. Leslie, C.E., with regard to the results of his examination of the Pentland Hills as a source of water supply. The general conclusion arrived at is, that 9,000,000 gallons per day may be obtained from the source in question at a cost of 320,000*l.* Of this quantity of water, 2,500,000 gallons is estimated to be obtained by increasing the storage in the Glencorse valley and other parts of the Pentlands dealt with by the present works. Mr. Forman's scheme, which proposed to give 7,000,000 gallons a day at a cost of 190,000*l.*, Mr. Leslie considers impracticable at the money, the probable cost, in his opinion, being 248,000*l.* Mr. Bateman estimated the quantity of water that could be obtained by Mr. Forman's scheme at 4,500,000 gallons, and Mr. Leslie thinks that something between that and 7,000,000 gallons might be got. Mr. Leslie's own scheme is said to be an entirely new one. He proposes to intercept the water from the south-east slopes of the Pentlands, and in doing so he takes a much lower level than Mr. Forman, and includes some agricultural land lying between Glencorse and Carlops. Among the additional works he proposes to erect are nine or ten new reservoirs, for city supply and compensation; and he also suggests that the pipe to be laid from Glencorse to Carlops should be made large enough to take in the Lyne, so that the supply from that stream may be turned to account at a future date. Including the Lyne, the additional supply to be got from the Pentlands would be between 13,000,000 and 14,000,000 gallons per day, which would cost about 500,000*l.* The committee are to meet again in a few days to resume consideration of the report, which is expected to be then submitted in a completed form.

New Dock for Berwick-on-Tweed.—The Berwick Harbour Commissioners have resolved to apply to Parliament for powers to construct a dock on the south shore of the river, near to the bridge. The total cost of the dock is estimated at 40,000*l.* The North-Eastern Railway Company have also agreed to connect the dock with their main line at Tweedmouth Station. This dock will unquestionably prove of great advantage to the shipping interest of Berwick.

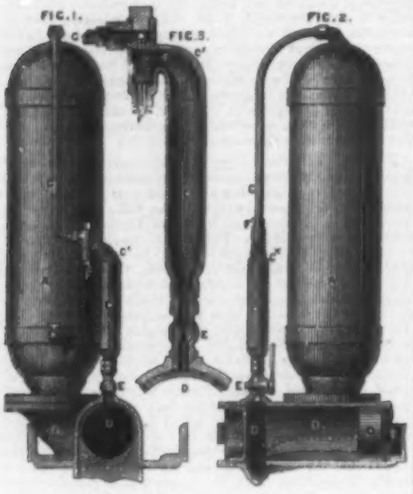
Death of an Old Cunard Servant.—The death has just been announced of Mr. Robert Thomson, who many years acted as resident engineer to the Cunard Company at Liverpool. Mr. Thomson was the elder brother of Messrs. J. and G. Thomson, the eminent shipbuilders and marine engineers of Glasgow. He had been associated with the Cunard Company from its commencement, and it is stated that he designed and modelled most of the vessels which form the company's fleet. Mr. Thomson was sixty years of age at his death.

Proposed Central Station in Dundee.—The Harbour Board and representatives of other public bodies in Dundee held a joint meeting last week for the purpose of adopting measures to induce the North British and Caledonian Railway Companies to agree to erect a central railway station suitable to the importance and wants of Dundee, and to adopt a proper system of railway communication through the town. A large and influential committee was formed, with powers to take such engineering advice as they might deem necessary. Mr. Charles Ower, the harbour engineer, has already given the committee an outline of a scheme which he deems sufficient to meet most, if not all the difficulties of the case.

GAS IN JAPAN.—Gas will shortly be introduced in the principal commercial town of Japan—namely, Yokohama—and in part of the city of Yedo—the seat of the Mikado's Government. The contract for the construction of the works required in this undertaking has been negotiated through the medium of Messrs. Miller Brothers, Glasgow, and has been intrusted by them to Messrs. Robert Laidlaw and Son, gas engineers, of that city. The first portion of the works, comprising about one-fourth of the entire undertaking, is now ready. The plans have been prepared by a French engineer, and the erection and management of the works will be conducted under his personal superintendence, while the labour will be performed by native Japanese workmen. The company is named the Yokohama and Tokio Gas Company.

SUPPLYING AIR TO AIR VESSELS.

We subjoin engravings showing a very neat arrangement employed by Messrs. Merryweather and Sons, of Long-acre, for maintaining the supply of air in the air vessels of their steam fire engines, Fig. 1 of our illustration being an end elevation partly in section of a portion of the engine; while Fig. 2 is a view taken at right angles to Fig. 1, and Fig. 3 represents a vertical section of the air feeder and end of the pump barrel. The air vessel, A, is of the ordinary construction, and is bolted on to the branch, B, leading from the delivery valve chamber as usual in steam fire engines of this kind. The body, C, of the air feeder is of cylindrical transverse section, and at its lower part the air feeder is connected as shown with the upper part of the end D of the main pump barrel of the engine, a cock, E, being provided for the purpose of closing the communication when necessary. The upper part of the air feeder is made with a bend, C^1, fitted with two ordinary spindle valves, F, F^1, both opening upwards, and this bend is connected by a connecting pipe, G, with the interior of the top of the air vessel, A.



The operation of this arrangement is as follows: As the pump piston, D^1, approaches the end, D, of the pump barrel the pressure of the water in the end, D, is caused to somewhat exceed the pressure in the air vessel, A, and the cock, E, being open, water from the end, D, of the barrel is forced up into the feeder, C, thereby compressing the air contained therein, so as to force it through the valve, F^1, and pipe, G, into the air vessel, A. On the return stroke of the piston, D^1, a partial vacuum is formed in the end, D, of the pump barrel, and consequently also in the feeder, C, the effect of which is that the pressure of the external atmosphere lifts the valve, F, whereby a fresh supply of air is admitted into the feeder, C, and the water contained therein flows down into the pump barrel. It will be obvious that the arrangement for compressing the air by means of water beneath it to a slightly higher pressure within a suitable feeder, C, than the pressure of the air contained in the air vessel, A, may as well as the form and arrangement of the feeder itself be more or less varied. The pressure of air may be retained in the air vessel, A, when the engine is at rest by closing the delivery valve or valves just before stopping the engine. We should mention in conclusion that this arrangement—which is a very neat and ingenious one—has been designed and patented by Mr. Edward Field and Mr. Richard M. Merryweather.

THE ENGLAND AND INDIA RAILWAY.

To the Editor of Engineering.

Sir,—Will you allow me to call attention to three great errors in Messrs. Low and Thomas's pamphlet?

1. In taking the line down France and through Italy and making a line down the coast of Turkey; when by going by existing lines along the North of France to Munich, and thence to Banjaluka, which is almost straight, they would then place the line in communication with the one already constructing from Banjaluka (*viâ* Novi Bosar, Uskup, and Philipopolis to Adrianople), a fact they do not seem to be aware of. This route would save some 200 or more miles, and render needless their estimate for rails in Austria and Turkey in Europe.

2. Again, who is to pay or help to pay for a line through the barren, unproductive, and unhealthy shores of Persia and Beloochistan, when, by going in a straight line *viâ* Diurbeker, Mosul, Lenza-Ispha Yezd to Moulton by Bholan Pass or the River Helmund to Cabul and Peshawur, they would pass through fine productive country, large cities, centres of commerce, &c.?

3. In their map, to get their line straight they have moved India towards the North Pole until it is sufficiently far from the equator as to be almost in the position where Siberia should be. Not content with moving it northwards they have turned it partly round. When I went to school our maps showed India pointing towards the south, but both India, Turkey, and Arabia, &c., are much out of place and position in this map.

Yours truly,

H. J.

RECENT PATENTS.

The following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 2855, 2s.) Julius Roberts, of the Old Rectory House, Seaford, patents the wonderful mode of constructing bridges, which we noticed on page 432 of our last volume.

(No. 2867, 4d.) Robert Punshon, of 3, St. Nicholas-buildings, Newcastle-on-Tyne, patents regulating the rapidity of explosion of gun-cotton, by coating the particles with sugar.

(No. 2689, 2s. 4d.) Andrew Ballantyne, of Glasgow, patents machinery for manufacturing wrought-iron and steel tubes. These arrangements are worthy of notice; but it would be impossible for us to describe them briefly.

(No. 2871, 1s. 2d.) William Dawes, of Kingston-grove, Leeds, patents an arrangement of compound horizontal engine, and also arrangements of valve gear for compound engines, and a form of three-ported valve. These plans it would also be impossible for us to describe here; but we may probably notice them at some future time.

(No. 2884, 1s. 4d.) Otto Trossin, of 4, Museum-street, patents an arrangement of hot air—or rather nitrogen gas—engine, the supposed advantages of which are founded on a fallacy. Mr. Trossin supposes that the specific heat of a gas decreases with an increase of pressure, and that, therefore, great advantages are to be gained by employing in his engine gas in a compressed state. The experiments of Regnault, however, long since proved the fallacy of the supposition that the specific heat of air or gases is diminished by increased pressure.

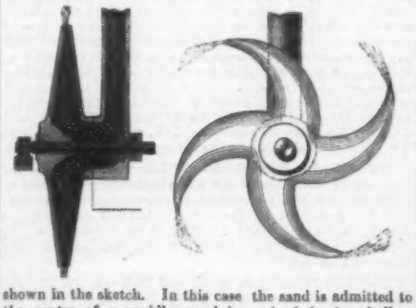
(No. 2886, 10d.) John Nathaniel Leeseware, of Bow-road, patents the arrangement of centrifugal drying machine illustrated by us on page 365 of our last volume.

(No. 2889, 4d.) William Henderson, of 97, Buchanan-street, Glasgow, patents a mode of increasing the proportion of carbon in pig iron, his system being intended to be used for the purpose of correcting irregularities in the working of blast furnaces. Mr. Henderson proposes to run the metal direct from the blast furnace into a furnace or receiver having a solid carbon bottom, this furnace or receiver being so constructed that it may be capable of being heated sufficiently to maintain the metal in a molten state during the time required for it to take up carbon from the bottom. From the receiver the metal is to be run into pigs in the usual way.

(No. 2891, 1s. 2d.) Rees Reece, of Llandilo, patents arrangements of refrigerating apparatus. We have spoken of Mr. Reece's plans in our articles on ice manufacture.

(No. 2894, 10d.) Richard Bewley, junior, of Uttoxeter, and Isaac Colton, of Longton, patent machinery for grinding gold and other colours. One of these machines was exhibited at the late show of the Royal Agricultural Society, at Wolverhampton, and was described by us on page 44 of the present volume.

(No. 2900, 8d.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of Benjamin Chew Tilghman, of Philadelphia, U.S., a method of cutting stone, &c., by the impact of particles of sand which have been set in motion with sufficient velocity by the direct application of mechanical force or by gravity. We have already described in these pages Mr. Tilghman's mode of cutting hard substances by a stream of particles of sand impelled by a jet of air or steam, and of this system that now patented is a modification. Mr. Tilghman proposes various methods of impelling the sand mechanically, amongst others that

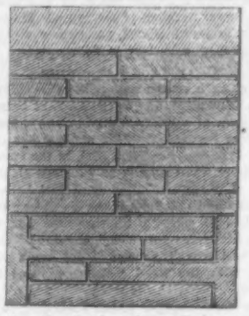


shown in the sketch. In this case the sand is admitted to the centre of a rapidly revolving wheel having hollow curved spokes, from the extremities of which it is discharged with the requisite velocity.

(No. 2904, 1s. 2d.) Samuel Oram, of 4, Kempson-road, Walham-green, patents what he terms a "cultor." This is a cultivating implement consisting of a number of cultivating tines, of a peculiar form attached to a circular frame which is made to revolve in a horizontal plane by steam power. The "cultor" is carried by a frame mounted on wheels, this frame also carrying the steam machinery which serves as the propelling power. We cannot but regard the whole arrangement, which the inventor euphoniously terms the "locomotor cultor," as very unpromising.

(No. 2906, 8d.) Thomas Arthur Dillon, of Dublin, patents a complicated arrangement for admitting heated air to the fireboxes of locomotives, &c. Mr. Dillon proposes to collect the air by trumpet-mouthed pipes at the sides of the smokebox, these pipes conducting it to an air chamber situated within the smokebox and from which it is conducted to the firebox through pipes led through some of the ordinary boiler tubes. The passage of the air along the last mentioned pipes is to be assisted by the action of jets of steam drawn from the exhaust. Regarded as an arrangement for giving trouble and aggravating engine drivers, we have no doubt that the contrivance will be found admirable.

(No. 2910, 8d.) Thomas Richardson, John W. Richardson, and Adam Smith, of West Hartlepool, patent a method of building up piles from which flanged or other rails are to be rolled. The annexed sketch shows this method of



building up the pile, the four lower layers, including the pieces of T-section, being of fibrous iron and the remainder of puddled iron. The pile is placed in the furnace in the position shown in the sketch, the slab for forming the head being uppermost. The object of the plan is stated to be to secure a thorough welding of the head and at the same time to prevent the lower parts, which form the flange, from being overheated.

(No. 2919, 10d.) Norman Stewart Walker, of Liverpool, patents machinery to be employed in the manufacture of lead-encased block tin pipe. We could not describe these plans briefly.

(No. 2923, 10d.) John William Kenyon, of Manchester, patents a steam boiler consisting of a number of vertical tubular units, each unit being cylindrical at the upper and conical at the lower part of its length. The units are connected at their lower ends by pipes for distributing the feed-water, and at the upper ends by pipes communicating with a steam receiver, and they are so set side by side in a flue of brickwork that the hot gases from the fire pass between them with a zigzag course.

(No. 2927, 1s. 8d.) William Low, of Wrexham, patents machinery for tunnelling or boring through chalk, coal, or similar materials. We could not describe this machinery briefly; but we believe we are correct in stating that it was specially designed by Mr. Low for employment on the tunnel under the English Channel, which he has been long advocating.

(No. 2940, 4d.) James Henderson, of New York, patents various methods of subjecting cast iron to the action of fluorine for the purpose of removing the sulphur, silicon, phosphorus, and carbon.

(No. 2952, 8d.) William John Cockburn-Muir, of Westminster, patents an arrangement of permanent way for tramways. In this arrangement, which we may, perhaps, illustrate at some future time, the rail is keyed to cast-iron chairs made of such form that they work in with the ordinary sets or stones of street paving.

(No. 2954, 1s. 10d.) John Addy Hopkinson and Joseph Hopkinson, junior, of Huddersfield, patent forms of composite safety valves consisting of two or more valves seated one upon the other. We could not describe these various plans briefly.

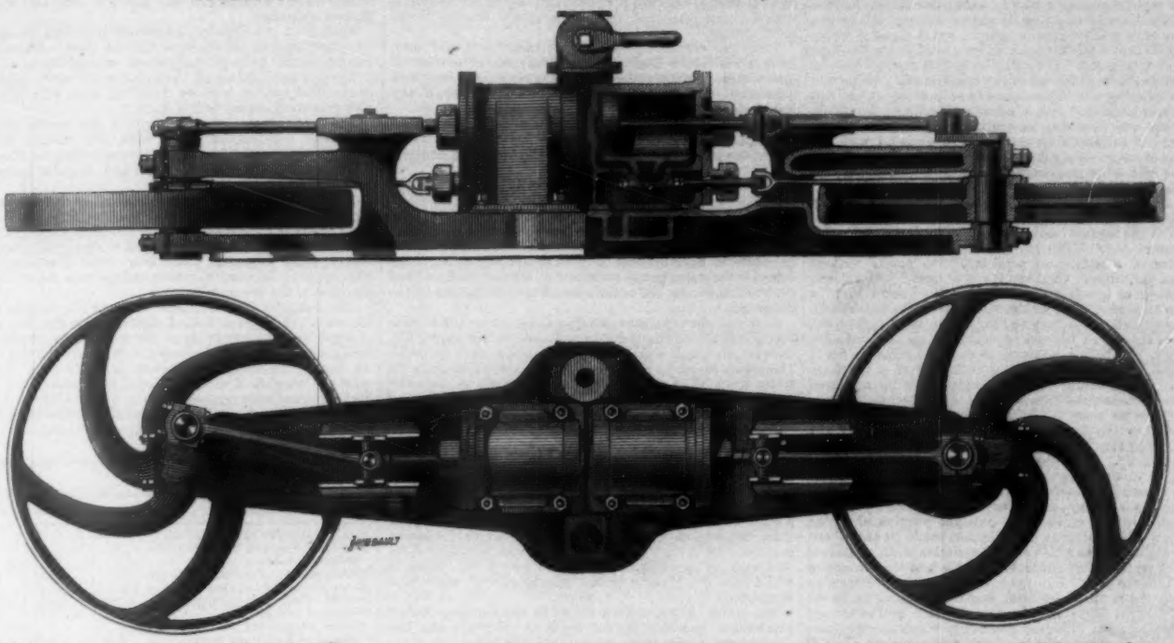
(No. 2959, 8d.) Edward Primrose Howard Vaughan, of 54, Chancery-lane, patents, as the agent of Lars Albert Leonard Söderström and George Alexander Dick, of Paris, an arrangement of gas engine, a description of which would occupy far more space than we can give to it here. We may mention, however, that it belongs to that class of engines in which the mixture of gas and air is exploded between two pistons, one of which is connected to a crank in the ordinary way, while the other moves loose in the cylinder and is driven to the end of the latter by the explosion and held there, the vacuum formed by the explosion then causing the piston first mentioned to be acted upon by the pressure of the external air. We certainly have no high opinion of this class of gas engines.

(No. 2963, 6d.) Albert Marcus Silber, of Wood-street, Cheapside, and Frederick White, of Camberwell, patent arrangements of railway carriage lamps adapted for burning petroleum and other mineral oils. As we intend to illustrate one of these lamps shortly, we need not describe the plans further here.

(No. 2964, 1s. 2d.) William Edward Gedge, of 11, Wellington-street, Strand, patents, as the agent of Jean Baptiste Honoré Petitpierre, of Mohon, France, a very wonderful arrangement of "agricultural steam engine" intended for steam cultivating purposes. It would require engravings to give a fair idea of the remarkable piece of designing, but these engravings we do not consider it worth while to prepare.

ENGINES FOR DRIVING CENTRIFUGAL DRYING MACHINE.

CONSTRUCTED BY MORT'S DOCK AND ENGINEERING COMPANY, BALMAIN, AUSTRALIA.



The addition of sugar to the products of our Australian colonies has caused several of the Sydney engineers to direct their attention to the construction of plant for the sugar manufacture, and a number of mills are now in working order. Amongst the firms just referred to is Mort's Dock and Engineering Company; and we give, above, engravings showing a pair of small horizontal engines constructed by them for driving sugar centrifugals. These engines were built from the designs of Mr. Norman Selfe, of Balmain, Sydney, and their arrangement, which is very simple, will be readily understood from the drawings without special description. These engines are found to answer their purpose well, and they are of interest as an example of colonial engineering.

ON THE USE OF PULVERISED FUEL.

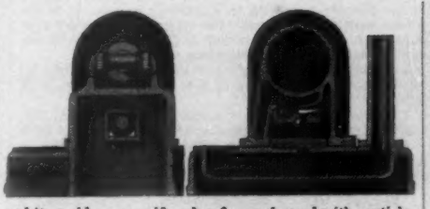
By Lieutenant C. E. Dutton, U.S. Ordnance Corps.

(*Concluded from page 230.*)

The kind of fuel employed is an important consideration. The best results are obtained with bituminous coal. In common grate burning, anthracite usually gives a more intense heat than soft coal, although its thermal equivalent is theoretically less. But in burning soft coal, the distillation of hydrocarbon vapours from the upper layers of the fire absorbs considerable heat, and as these are subsequently burned only very imperfectly, and with great loss by smoke, much of the thermal power of this coal is lost. In the reverberatory furnace the long flame of bituminous coal is required to fill the hearth, while anthracite would yield only an intense heat in the fire-place, and a flame short and of small intensity in the hearth. With pulverised fuel the full, long, abundant flame, and the great temperature due to the higher thermal equivalent of bituminous coal, are both realised—a fact abundantly sustained by practice, and in itself a proof that the combustion is more complete.

But very good results are attainable with anthracite, the chief objections to it being that it requires more power to pulverise it, and that it does not ignite so readily. A slight admixture of bituminous coal will quicken the ignition very materially. Preparatory to pulverising, the coal must be reduced to gravel, so as to enter the machine easily. This is done in a breaker or crusher, which is run at very small expense; a single crusher being sufficient for a large mill with many furnaces.

There remains to be considered what modification of the chemical effects of the flame would attend the use of pulverised fuel in the reverberatory furnace. There are certainly differences in the conditions under which the oxidising or reducing influences of the flame are exerted, as compared with the old method. In the case of pulverised fuel, we have the entire mass of the coal, ashes and all passing through the hearth. In some parts of the hearth we have free carbon and free oxygen uncombined, which sweep over the surface of the bath, and occasional particles falling into it. Somewhat similar conditions, but less in degree, attend the use of solid fuel, and I cannot but think that the effect of the pulverised fuel in carbonising or oxidising the metal will be determined by the conditions, of the flame itself, i. e., whether oxygen or carbon preponderates. Although there is commonly present in the furnace both free oxygen and free carbon, yet the probabilities would seem to be that the metal would still be deoxidised when the oxygen is in any degree in excess of the demands for combustion, and would be carbonised when oxygen is deficient. In the case of puddling, the metal is powerfully protected by the supernatent slag. In heating iron piles, a neutral flame is obviously essential,



and it would seem as if such a flame, charged with particles of solid carbon impinging against the soft white mass, would carbonise it. But if this were actually the case, how does it happen that the piles are not carbonised in the old way by the smoke, which abundantly fills the whole hearth, and is pure carbon in a spongy state, almost molecularly subdivided, and, therefore, seemingly in a condition most favourable for the production of this very effect. If such action can take place anywhere, it certainly ought to take place in the puddling furnace immediately after balling, and just before the balls are drawn. The purified iron is then not only rolled up out of the slag, and naked to the flame, but is in that peculiar spongy state in which it exposes a very great surface to it, and is at the same time exposed to the highest heat. The abundant experience hitherto had with pulverised fuel shows no such action, and with a properly managed flame it probably does not occur. As to the use of this fuel for melting wrought iron and steel in open hearths, experience has not yet been sufficient to warrant a conclusion in this regard. In the experiments it would seem that the iron was carbonised to some extent, but the flame was overcharged with fuel.

II. *The use of pulverised coal in generating steam.*—The foregoing considerations are, with suitable modifications, applicable to boiler practice. As every fuel has the power of generating by combustion a fixed quantity of heat—a quantity which it is at present impossible to convert into its maximum useful effect by any method—the problem therefore becomes a question as to what is the method which will enable us to approach most nearly to this maximum useful effect. Part of the potential heat is never developed, because not all of the carbon and hydrogen can be oxidised, or rather peroxidised. Part of the heat developed by combustion is carried out at the chimney, and lost altogether, thus failing to exert any useful effect by absorption into the boiler. Part of the heat absorbed into the boiler is lost by radiation from the external shell before it can be converted into work in the steam cylinder—and so on; each source of loss being very serious, robbing the engineer of a large percentage of his resources. The ultimate store of power which he is able to convert to actual uses is but a small percentage of the whole amount originally contained in his fuel. The use of pulverised coal involves a striking economy by the prevention of loss from two of the sources just mentioned, viz., from imperfect combustion and from failure to absorb all the heat generated. It does not indeed prevent all losses from these causes, but materially reduces them. The defects of the grate-burning method have perhaps been sufficiently discussed. Many attempts have been made to overcome them, and some valuable improvements have been accomplished, the most important of which are devices for admitting air over the fire. But, inventions intended to regulate the supply of air in conformity with the progress of combustion in the coals, and those intended to consume smoke, have fallen into general disfavour, so far as economical results are concerned. They all involve inconveniences or losses which more than compensate their advantages. The essential conditions upon which a real economy of combustion must be founded are well enough understood, but the difficulty of attaining them has been inherent in the defects of the mode by which air and fuel are made to react upon each other. The admission of air over the grate is only a partial remedy, and fails to effect the one all important condition of instantaneous and perfect intermixture. Considerable quantities of smoke and carbonic oxide have always been, and always must be, carried from the grate through the flues into the atmosphere, so long as this mode of firing is continued. But a source of loss quite different from imperfect combustion will appear when we come to examine into the conditions attending the transmission of heat from the gases to the heat-absorbing surfaces and interior of the boiler. In order that heat may be transmitted from one material to another, it is necessary that the temperature of the two be different, and the rate at which it is transposed will be a positive function of this difference. Again, the transmission of heat through a plate of metal requires time, and the longer the heat-giving body is in contact with the plate, the more heat will be transmitted. It has been stated that the average amount of air supply to the grate is at least twice the theoretical quantity necessary for complete combustion. This amount is found practically to give the best results, on an average, with that method of firing. Let us assume, as no doubt can be easily shown in practice, that the air supply for pulverised fuel need not be more than 50 per cent. in excess of the theoretical minimum. We have at once a diminished volume of escaping gases, and a corresponding increase in their temperature. In effect, then, we have a largely increased difference between the temperatures of the two sides of the plate and an increased transmission. But this is not all. The rate at which heat is transmitted, increases in a higher ratio the difference of these two temperatures. For example, let us take two cases, one of a plate whose interior surface is in contact with water at 250°, and its exterior in contact with gases at 1000°; the other plate of whose interior is in contact with water at 300°, and its exterior in contact with gases at 1300°. Now, not only will the transmission be absolutely greater in the second case than in the first, by reason of the wide difference of temperature in the two surfaces, but it will be greater for each degree of difference. Again, a reduction in the volume of gases implies a corresponding reduction in the velocity with which they pass through the flues, and therefore increases, in the same ratio, the time during which they are in contact with the heat-absorbing surfaces.

It must be borne in mind that the advantages here indicated are not peculiar to pulverised fuel alone, but are applicable to all flames of high temperature. The superior economy of high temperatures over lower ones (so long as they are not destructive to the boiler or fire-chamber) is a principle susceptible of the fullest demonstration.

The foregoing discussions are by no means wholly new. The principles and facts involved in grate-burning have long been understood to be substantially as stated, and have been practically assumed in all rational attempts to construct smoke-burning fireboxes. Mr. Bourne, in his great treatise on the steam engine, has illustrated and discussed them in his descriptions of numerous contrivances for this purpose. The abatement of the smoke nuisance is one of the great problems of English mechanical engineering, having been made the subject of innumerable patents and several parliamentary investigations. But such investigations seem to have

ended just where they began—in smoke. Hence, no doubt, Mr. Bourne was led to make the following significant statements: "Nearly all the expedients hitherto introduced for burning smoke in locomotives, are adaptations of the devices heretofore in use for burning smoke in land engine furnaces. But the rapid combustion which a locomotive boiler requires, renders the burning of smoke by any of these ancient devices a matter of very difficult achievement, and it seems to be indispensable that a method founded on a totally new principle should be introduced. It appears to us that the fuel and the air must be fed in simultaneously; and the most feasible way of accomplishing this object seems to be in reducing the coal to dust and blowing it into a chamber lined with fire brick, so that the coal dust may be ignited by coming in contact with red hot surfaces after having been mingled with the quantity of air necessary for combustion. This, however, in common with other improvements upon the locomotive, requires to be worked out."

The foregoing discussions have been based upon the assumption that the conditions of burning pulverized fuel are realised in the manner calculated to yield the best results. The present stage of this invention lacks, as yet, some few requisites of completeness, and is by no means without practical difficulties. Of these, the most important relates to the manner of igniting the dust. It would seem that, in order to be perfect in its action, the flame of the fuel should be self-sustaining, and keep up the ignition steadily from the mouth of the tuyere, without any adventitious aid from a gas generator. If the gas generator be removed while the fire is under full headway, there will be no falling off in the flame at first. On the contrary, if the supply of air be regulated by the requirements of the coal, the heat will be more intense, but at the same time the point of ignition will slowly push forward into the furnace, and the brickwork around the tuyere, being thus removed from or abandoned by the flame, will cool down. Now, it might seem as if this could be remedied by diminishing the velocity with which the fuel and air are poured into the furnace, which might be done by increasing the aperture of the tuyere. Supposing this to be practicable, instead of having a constant position where the ignition would commence, that position would be one of unstable equilibrium, in which a slight variation of circumstances would cause the flame either to advance into the furnace or recede into the pipe. In a word, it is necessary to determine definitely the point of ignition, and there seems to be no way of doing it better than by bringing the coal in contact with burning gas. Now, the generator, which accomplishes the ignition, is otherwise detrimental to the highest effect of the fuel, since, so far as it goes, it reproduces all the disadvantages of grate-burning, with its excessive supply of air, which takes up heat and diminishes temperature. But since it is made very small—as practicable—its effect is correspondingly small in diluting the effect of the fuel. It is to be hoped, however, that the rare ingenuity of the inventors will enable them to discover some equally certain means of igniting the fuel without even these small disadvantages.

In conclusion, there is appended the statement of Messrs. Whelpley and Storer, of the work performed by their pulverisers.

"The 18-inch pulveriser, commonly applied to furnaces, reduces 200 lb. per hour of anthracite coal, the proportions of size being about like the yield of millstones. It requires about 3½ horse power to effect this. The same power reduces 300 lb. of bituminous coal, a large proportion of it being very fine. The entire yield will burn easily, wafted through a hot furnace. A 42-inch pulveriser, requiring about 15 horse power, will deliver 1000 to 1200 lb. of anthracite per hour, 2000 lb. of bituminous coal, 2500 to 3000 of quartz, 2000 to 2500 lb. of top cinder, 3500 to 4000 lb. of limestone, 900 lb. of unburned bone, and 50 bushels of wheat. With an increase of power we have ground 1 bushel of wheat per minute, finer than is done with millstones, and 6000 lb. of copper ore in limestone gangue."

"A comparison of these figures with stamp work, or any other method of pulverising, would show very great economy, whether in cost of machines, attendance, wear and tear, or power consumed."

BOILER EXPERIMENTS AT THE LOWELL BLEACHERY.*

By E. D. Leavitt, Jun., Mechanical Engineer.

The experiments described in this paper were made at the request of F. P. Appleton, Esq., agent of the Lowell Bleachery, at Lowell, Massachusetts, the object being the determination of the relative advantages of different types of boilers for the service required by that company.

Three varieties of boilers were tried, viz.:

The Harrison cast-iron boiler; the double-flued "Hognose" boiler, known in England as the "Batterley" boiler; and the externally fired, cylindrical tubular boiler, commonly known as the "plain tubular boiler."

An experiment of three days' duration was made with each of the two first-named boilers, which was conducted in the following manner, viz.:

1. The coal was carefully weighed.

2. The water supplied to the boilers was measured in a tank that was uniformly filled to a certain height.

The following data were recorded every half hour, from 5 a.m. to 6 p.m., observations being made at intervals of 15 minutes, and the mean of two observations entered on the record, viz.:

3. The pressure of steam, as indicated by the gauges attached to the boiler.

4. The temperature of the steam issuing from the boilers, which was obtained from a thermometer inserted in the main steam pipe, near its junction with the steam-drum.

5. The temperature of the feed-water entering the boilers, taken from a thermometer inserted in the feed pipe.

6. The temperature of the water taken from the tank.

7. The temperature of the atmosphere in the shade.

8. The temperature of the fire room, near the boilers.

9. The force and direction of the wind.

10. The state of the weather.

a. The temperature of the flues leading from the boilers to the chimney was frequently observed.

b. The wood used in kindling fires was weighed.

To insure results that might be depended upon for continuous service, care was taken that all the details connected with the management of the boilers should conform to the usual routine.

There was necessarily considerable variation in the water level of the boilers during the experiments, on account of intermittent feeding, which the tank measurement rendered unavoidable; it is not probable, however, that much, if any loss of economy resulted from this fact.

Fresh fires were started every morning during the experiments, which were burned out after the day's work was done; the furnaces being cleared of their contents of ashes, clinkers, and unburned coal during the night.

Boilers operated in this manner will not give as high evaporative results as those that are worked continuously night and day, or those in whose furnaces the fires are banked at night. It was stated that the plan followed had proved the most advantageous for the company, it being necessary to have the best of clean bright fires to meet the demands for steam in the early part of the day, and personal observation during the experiments was confirmatory of the statement.

Care was taken to observe whether the steam supplied by the boilers was dry or charged with moisture; it was impossible, however, to reach a satisfactory conclusion on this point. There were evidences at times of the presence of water in the steam drum of the Harrison boilers, and the steam thermometer attached to the flue boilers indicated an average temperature of 6½° below that due to the average pressure as given by Regnault's tables; this was in a measure accounted for by the fact that the steam pipe in which the bulb of the thermometer was inserted was too small to transmit the volume of steam (generated by the flue boilers) without considerable wire drawing; while the steam gauge was connected directly with the steam drum, and probably indicated a somewhat higher pressure than was contained in the pipe.

In the experiment with the tubular boilers the steam generated by them, together with that from six other boilers, was used by an engine of 400 horse power, the action of which gave no evidence of the passing over of water with the steam.

The steam thermometer attached to the Harrison boilers was broken by water the first night of the trial; the first day's record gave a mean temperature 5.15° above that due to the pressure according to Regnault's tables. It is not certain that the thermometer was correct, as it was not compared with the standard previous to the trial, and its breakage precluded any such comparison subsequently.

The Harrison boiler experiment commenced at 6.30 a.m., September 13th, and ended at 6.30 a.m., September, 16th, 1870.

The flue boiler experiment commenced at 6.30 a.m., September 20th, and was concluded at 6.30 a.m., September 23rd.

A summary of the results obtained, together with the leading dimensions of the boilers, arranged in parallel columns for comparison, is as follows, viz.:

Summary, &c.	Harrison Boilers.	Flue Boilers.
Date of experiment, 1870...	Sept. 13th to 16th.	Sept. 20th to 23rd.
Duration of experiment	3 days.	3 days.
Number of boilers tried	2	2
Size of the boilers	50 horse power.	4 ft. dia. × 30 ft. long.
Aggregate HP. of boilers tried ...	100 horse power.	100 horse power.
Total grate surface of boilers tried	92 square feet.	48 square feet.
Total fire surface of boilers tried ...	1300 square feet.	948 square feet.
Ratio of heating surface to grate surface	28.85 to 1	19.75 to 1
Mean pressure of steam observed	60.9 lb.	62.32 lb.
Mean temperature of steam (Fahr.) observed ...	*213.31 deg.	303.69 deg.
Mean temperature of steam (Fahr.) by Regnault's tables for the pressure observed ...	308.03 deg.	310.2 deg.
Mean temperature of water in tank	67.27 deg.	65.86 deg.
Mean temperature of feed water entering boilers ...	144.91 deg.	135.89 deg.
Mean temperature of the atmosphere in the shade ...	70.22 deg.	65.85 deg.
Mean temperature of fire room ...	91.93 deg.	93.09 deg.
Direction and force of the wind ...	Variable and Light.	Variable and Light.
State of the weather	Fair.	Fair.
Total quantity of water evaporated during trial, in lbs.	116,604	99,687
Total quantity of coal consumed during trial, in pounds	16,125	14,187
Ashes and clinkers in the coal, lbs.	1,552	1284.5
Ashes and clinkers in the coal, per cent.	9.62	9.04
Water evaporated by 1 lb. of coal, from temperature of feed, lbs. ...	7.23	7.03
Equivalent evaporation from and at 212°, lb. ...	7.95	7.8
Relative economy of the boilers ...	101.9	100
Relative quantities of water evaporated by the boilers in equal times or steaming efficiency	117	100

One day.*

The temperature of the flue leading from the Harrison boilers varied from 290° to upwards of 600°; the heat was sufficient to break a thermometer graduated to 620° on the first day of the experiment, and subsequently to melt lead.

The temperature of the flue leading from the Hognose boilers ranged between 310° and 510°; usually 420° was the highest indication.

Neither set of boilers had a first-rate draft, and one seemed to operate against the other, so that the ash-pit doors of the flue boilers had to be partially closed most of the time.

The coal used during all the experiments was Cumberland of excellent quality, burning clean and clear, with less than 10 per cent. of incombustible matter.

For the purpose of comparison with the results obtained from the experiments made with the tubular boilers, February 17th and 18th, 1870, a corresponding set of experiments was made with the Harrison and Hognose boilers, as follows:

At or soon after the commencement of work on the morning of each day (that the boilers were under trial) the fires were carefully examined and their condition noted. Late in the afternoon the fires were brought to an equally good condition (as far as careful observation could determine), and the interval between the observations was taken for the duration of the experiment.

The data for these experiments were (in the case of the Harrison and Hognose boilers) obtained from the daily record referred to at the beginning of this paper; these experiments being carried on simultaneously with those first described. In the tubular boiler experiments the only data recorded were the weights of water and coal, the temperature of the feed water and the pressure of steam. The weather at the time was cold and stormy, with strong winds, so that the outward circumstances of the trial were not as favourable as in the case of the other boilers.

The results obtained from these experiments stand as follows, viz.:

Type of Boiler.	Harrison.	Hognose.	Tubular.
Number of experiments tried ...	2	3	2
Aggregate duration of experiments, in hours	24.87	26.25	18.5
Mean pressure of steam, in lbs.	62.76	64.89	63.43
Mean temperature of feed water	145.08°	134.49°	69.87°
Pounds of water evaporated ...	88164	79008.6	92586.6
Pounds of coal burnt	8502	8730	9195
Water evaporated by each pound of coal, from temperature of feed, in pounds	9.23	9.01	9.96
Equivalent evaporation from and at 212°, in pounds ...	10.2	10.01	11.8
Relative economy of boilers ...	102	100.1	118
Relative steaming efficiency of boilers	102.35	100	144.2
Coal burned per square foot of grate per hour, in pounds	7.35	7.05	10.51
Water evaporated per square foot of fire surface, per hour, in pounds	2.36	2.19	2.53
Grate surface, aggregate sq. ft ...	52	48	48
Fire " " " ...	1500	948	1985.1
Ratio of fire surface to grate, square feet	28.85 to 1	19.75 to 1	41.3 to 1

The capacity of the tank was found by weighing the quantity of water that was required to fill it to the gauge mark, the temperature of the water being observed and corrections made for any differences of temperature during the experiments.

The steam gauges were tested at the close of the experiments by the American Steam Gauge Company, and the thermometers by Huddleston, the well-known maker (both of Boston), and corrections were made for each observation recorded to bring it to the standard, as shown by the tests.

In the experiment with the tubular boilers the gauges were reported correct, having been recently tested. No additional test was, therefore, made at the conclusion of the experiments.

The Late Mr. Thomas Livesey.—Mr. Livesey, Secretary to the South Metropolitan Gas Company for nearly 30 years, went to see his physician last Wednesday week, and fell dead while in the surgery. The deceased has for many years taken a prominent part in connexion with public charities in the neighbourhood of Peckham and Dulwich.

Cleveland Institution of Engineers.—At a meeting of the Council of the Cleveland Institution of Engineers held on Saturday the 14th inst., it was decided to engage a permanent secretary. Mr. Jeremiah Head was elected the new president, and Messrs. T. Wrightson and E. F. Jones were added to the list of vice-presidents. Several valuable papers are forthcoming for the ensuing session.

Patents.—From the report of the commissioners of patents for the year 1870, which has just been issued, we find that during that year 3405 applications were made for letters patent, while the number of patents passed was 2160 and the number of specifications filed 2140. Thus the number of applications lapsed or forfeited, the applicants having neglected to proceed for their patents within the six months of protection, was 1225; and the number of patents void in consequence of the patentees neglecting to file specifications was 40. The report, as we have said, is for the year 1870; but we notice that its compiler even at that date included Alsace amongst the possessions of Germany. This is an instance of brilliant prescience which would be invaluable to an employé of Zadkiel. The latter part of the report is much the same as usual. The commissioners again—and with good reason—urge their demands for more commodious accommodation, and there is a balance sheet showing—also as usual—an enormous surplus income. This surplus was for the year 1870, 65,501*l.* 3*s.* 11*d.*, while the aggregate surplus income on balance of accounts from 1st October, 1852, to end of 1870 amounts to 857,200*l.*

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* From the *Journal of the Franklin Institute.*

GERMAN RAILWAYS.

THE CONSTRUCTION AND MAINTENANCE OF PERMANENT WAY.

IT is somewhat curious that in this country with its vast network of railways there should be no association or society having for its special object the investigation and discussion of the various details of railway construction, maintenance, and management. It is true that the Institution of Civil Engineers, the Institution of Mechanical Engineers, and several other kindred societies devote a portion of their time to the consideration of some of the subjects to which we have referred; but there are numerous details of railway management which do not come within their scope at all, while those which do are rarely discussed so thoroughly as it is desirable that they should be. In America the want of some means of discussing and comparing various features of railway management has led to the formation of the "Master Mechanics' Association," the term "master mechanic" being synonymous in the United States with our "locomotive superintendent," and this society will, no doubt, in

TABLE No. I. SHOWING THE RESULTS OBTAINED WITH RAILS OF PUDDLED STEEL.

Reference Number.	Name of railway on which the rails were used.	Name of works from which the rails were supplied.	Quantity supplied.	Weight of rails per yard.	Height of rails.	Length of line over which the rails have been laid down.	Total load which has passed over the line expressed in millions of tons.	Nature of line on which the rails have been laid. Radii of curves.	Gradients.	Average daily number of trains.	Average number of years during which the rails have been under traffic.	Period of guarantee.	Percentage of the total number of rails which had to be renewed during the period of guarantee.	Percentage of the total number of rails which have had to be renewed since they were first laid down.	Remarks.
			tons.	lb.	in.	miles.		ft.			years.	years.	per cent.	per cent.	
1	Altona-Kiel Railway.	Phœnix Iron Works, Ruhrort	280.24	72.32	4.5	2.77	...	1504.24	1 in 140	6 to 15	4	...	...	1.0	These rails were mostly laid down at switches, &c., where there was a heavy traffic, and hence the wear and tear was greater than that of the steel rails laid down on the open line of the same railway. These rails had generally to be renewed on account of the flattening of the top.
2	State Railway of Baden	" "	227.9	84.36	4.72	1.8	...	832.8 and 1968 and straight line	1 in 60	5	4½	4	...	ab't. 0.2	Two rails renewed.
	" "	" "	1225.5	...	...	7.9	...		1 in 80	...	2	...	...	ab't. 0.1	Three rails renewed.
3	Berlin-Anhalt Railway	Funke and Elbers, of Hagen	71.3	79.9	4.9	0.44	...	straight and curves of 1174 ft., 2470 ft., and 10,106 ft. radius	1 in 230 and 1 in 130	10—14	3 2	...	...	4.75	The renewed rails were flattened at the top.
4	Brunswick State Railway	Hüttenverein Hörde	246.0	84.36	4.64	2.02	...	...	almost horizontal	10	6½	3	0.009	0.2	These rails have been found to answer well.
5	Upper Silesian Railway	Association Minerva, Breslau	867.7	85.14	5.12	4.65	...	6175.24	1 in 60 and 1 in 300	34—44	2½	5	1.86	1.86	
6	Eastern Railway of Prussia	" "	25.0	80.62	5.12	0.202	...	...	...	...	3½	...	...	...	These rails are laid down principally at stations where heavy shunting takes place. About 50 per cent. of them show partly small impressions and partly flattening of the top.
7	Rhenish Railway ...	not given	38.5	...	...	abt. 0.31	...	...	1 in 38, laid on the inclined plane at Aachen-Houheide	...	5	...	...	47.9	Besides the 47 per cent. already renewed, there are 38 rails which will soon have to be replaced, so that shortly 63 per cent. of these rails will have been renewed.
8	State Railway (Western) of Saxony	Funke and Hueg, of Hagen	31.7	69.31	4.6	0.313	...	none	1 in 100	56—58	7	4	3.261	4.347	Laid down in 1866.
	" "	" "	8.5	69.31	4.6	0.084	...	straight and 744.5 ft. radius	1 in 100 and 1 in 40	50	8	4	24.0	70.0	
9	Kaiser-Ferdinand Northern Railway of Austria	Teschen	566.15	83.39	4.28	4.41	22.28	3110 ft.	1 in 240	36	7½	3	0.41	2.26	
	" "	"	142.07	83.39	4.28	1.17	17.11	3110 ft.	1 in 239	36	5½	3	0.31	0.45	
	" "	"	308.82	83.39	4.28	2.55	12.87	straight	" "	34	4½	3	1.38	3.20	
	" "	Stefanau	609.13	83.39	4.28	5.05	13.87	"	" "	35	4½	3	3.25	6.37	
	" "	Witkowitz	296.27	83.39	4.28	2.45	11.29	"	1 in 300	35	3½	3	1.75	1.75	
	" "	Teschen	929.02	83.39	4.28	7.86	11.29	"	" "	35	3½	3	0.22	0.22	
	" "	"	823.31	83.39	4.28	6.82	9.6	"	1 in 400	46	3½	3	0.65	0.65	
	" "	"	186.74	83.39	4.28	1.54	9.6	"	" "	46	3½	3	0.11	0.11	
	" "	"	583.11	83.39	4.28	4.82	9.16	"	" "	46	3½	3	0.14	0.14	
	" "	"	324.28	68.98	4.75	3.34	7.8	"	" "	38	2½	3	0.30	0.49	
	" "	Zeltweg	583.26	68.98	4.75	5.84	6.35	"	1 in 3000	39	2½	3	0.96	1.67	
	" "	Witkowitz	293.86	68.98	4.75	2.94	6.98	"	1 in 300	48	2½	3	0.68	0.29	
	" "	"	188.16	68.98	4.75	1.88	6.98	"	horizontal	48	2½	3	0.22	0.76	
	" "	"	313.4	68.98	4.75	3.14	9.17	3732.6	1 in 300	35	2½	3	3.46	5.90	
	" "	Teschen	56.72	68.98	4.75	0.56	5.62	2488.2	" "	18	2½	3	0.44	1.51	
	" "	"	136.10	68.98	4.75	1.35	5.17	straight	1 in 2000	39	2	3	0.00	0.00	
	" "	Witkowitz	465.93	68.98	4.75	4.63	5.62	"	horizontal	39	2	3	0.81	1.47	
	" "	Teschen	527.34	68.98	4.75	5.26	6.17	"	1 in 600	29	2	3	0.28	0.43	
	" "	"	333.52	68.98	4.75	3.33	5.73	6220.8	" "	29	2	3	0.65	0.83	
	" "	"	347.21	68.98	4.75	3.48	5.96	2488.2	1 in 300	18	2	3	0.15	0.85	
	" "	Witkowitz	15.50	68.98	4.75	0.15	...	3732.6	" "	30	2	3	...	...	
	" "	Teschen	22.44	68.98	4.75	0.22	6.56	straight	" "	48	2	3	0.00	0.00	
	" "	Witkowitz	221.64	68.98	4.75	2.22	2.09	"	" "	48	2	3	0.94	1.23	
	" "	Teschen	515.92	68.98	4.75	5.17	4.81	"	" "	48	2	3	0.15	0.31	
	" "	Witkowitz	612.25	68.98	4.75	6.13	7.09	"	" "	48	2	3	0.03	0.45	
	" "	Teschen	432.54	68.98	4.75	4.39	4.49	"	1 in 3890, 1 in 1800, and 1 in 500	32	1½	3	0.19	0.19	
	" "	"	535.41	68.98	4.75	5.36	4.10	straight and 4976.4	1 in 556, 1 in 500, and 1 in 621	32	1½	3	0.19	0.19	
	" "	Stefanau	466.45	68.98	4.75	4.67	2.02	straight	1 in 620 and 1 in 1653	24	0½	3	0.00	0.00	
	" "	"	802.21	68.98	4.75	8.04	2.02	"	1 in 606 and 1 in 505	24	0½	3	0 03	0.03	
	" "	Teschen	75.90	68.98	4.75	0.76	3.14	"	1 in 600 and 1 in 300	26	1/12	3	0.27	0.27	
	" "	"	489.79	68.98	4.75	4.91	2.03	straight, 4976.4, 2488.2, and 1804	1 in 300	16	0½	3	0.46	0.46	
	" "	"	158.91	68.98	4.75	3.59	1.51	straight, 2286.8, 2488.2, and 4976.4	1 in 1000, 1 in 420, 1 in 270, and 1 in 300	16	0/12	3	0.13	0.18	
	" "	"	208.52	68.98	4.75	2.09	2.20	straight	1 in 1000 and 1 in 550	16	1½	3	0.69	0.80	
	" "	"	688.60	68.98	4.75	6.87	1.51	straight, 2177.8, 3110.4, 2488.2, and 4976.4	1 in 1200 and 1 in 500	13	0½	3	0.00	0.00	
	" "	Witkowitz	723.14	68.98	4.75	7.25	2.02	4354.6, 5847.9, 5163.4, 5723.2, 5412.3, 6276.6, and 5972.2	1 in 300, 1 in 220, 1 in 400, 1 in 180, 1 in 1000, 1 in 800, and 1 in 700	29	0½	3	0.00	0.00	
	" "	"	279.95	68.98	4.75	2.80	1.21	straight	1 in 300	16	0½	3	0 08	0.08	
	" "	"	729.26	68.98	4.75	7.31	1.72	straight, 3732.6, and 4976.4	1 in 400, 1 in 2500, 1 in 800, and 1 in 300	16	0½	3	0.19	0.19	
10	Kaiserin Elisabeth Railway of Austria	Count Henkel, of Donnersmark, Zeltweg	622.97	80.06	4.92	5.45	...	Partly straight and partly curves of from 1344 ft. to 27,275 ft. radius	partly horizontal, partly gradients of 1 in 100 to 1 in 1175	14	8½	7	10.494	10.494	Chiefly failed through flattening of the top and peeling off of a portion of the rail.
	" "	"	769.15	80.06	4.92	6.62	...			14	3	7	11.733	11.733	
	" "	"	883.98	80.06	4.92	7.43	...			14	2½	7	4.477	4.477	
	" "	Klein, of Stefanau	130.67	80.06	4.92	1.12	...			14	4	7	5.625	5.625	
11	Southern Railway of Austria	" "	20.4	81.36	4.76	0.17	...	935 ft.	1 in 90	12	4	1	...	24	
12	Junction of the Southern line of North Germany	" "	108.86	66.96	4.32	2.22	...	909, 994.8, and 1244	1 in 200 and 1 in 300	12	1	5	...	...	
		Totals ...	19954.32			166									

TABLE II.—Showing the Results obtained with Cemented Rails.

Reference Number	Name of railway on which the rails were used.	Name of works from which the rails were supplied.	Quantity supplied.	Weight of rails per yard.	Height of rails.	Length of line over which the rails have been laid down.	Nature of line on which the rails have been laid. Radii of Curves.	Gradients.	Average daily number of trains.	Average number of years during which the rails have been under traffic.	Period of guarantee.	Percentage of the total number of rails which have had to be renewed during the period of guarantee.	Percentage of the total number of rails which have had to be renewed since they were first laid down.	Remarks.
			tons.	lb.	in.	miles.	ft.			years.	years.	per cent.	per cent.	
1	Altona-Kiel Railway	Phœnix Iron Works, Ruhrort...	62.30	72.32	4.5	0.596	1302	1 in 140	6 to 15	4	...	...	0.6	These rails were mostly laid down at switches, &c., where there was a heavy traffic, and hence the wear and tear was greater than that of the steel rails laid on the open line of the same railway. These rails had generally to be renewed on account of the flattening of the top.
	" "	" "	24.46	72.32	4.5	0.234	...	...	...	1	...	...	...	
2	Bergisch-Märkisch Railway	Not given	about 91.	...	...	abt. 0.906	...	...	...	4	...	...	11.4	
3	Berlin-Hamburgh Railway	Phœnix Iron Works, Ruhrort	51.43	81.5	4.72	0.434	Straight	1 in 16,000	15	1	5	...	...	These rails stood well in the most exposed places.
4	Cologne-Minden Railway	" "	1056.87	82.0	5.12	8.923	No particulars given		...	5	Trial rails.	...	9.0	Laid down on shunting lines.
										3½	"	...	none	
										2	2 to 5	...	0.8	Laid down on mountain lines.
										1	"	0.74	0.74	
5	Leipzig-Dresden Railway	" "	27.42	72.3	4.6	0.166	492	...	150 to 330	2	...	...	29.5	Of the number of rails (98).
										3	...	...	10.2	
										4.7	...	...	14.4	
6	Lower Silesian Railway	" "	24.10	80.5	5.12	0.304	2959 to 12,354	1 in 377	20 to 30	2½	5	...	...	The last supply of about 7 tons has been partly flattened at the top, on account of the hardness not being uniform.
7	Eastern Railway of Prussia	" "	122.65	82.57	5.12	0.185	...	1 in 200	12; many trains are broken up and united over these rails.	3	3	...	...	A small number of these rails showed a peeling off at the top.
8	Rhenish Railway	Not given about	12.93	...	...	abt. 0.102	...	1 in 38 inclined plane; Aix-la Chapelle, Bombelle	...	5	...	...	80.3	Cemented rails with hardened top. The remaining 20 per cent. are also already injured.
		about	12.93	...	...	abt. 0.102	...	" "	...	5	...	...	0.0	Cemented rails the top of which is not hardened. Have answered well.
9	Western State Rlwy. of Saxony	Phœnix Iron Works, Ruhrort	18.86	69.41	4.6	0.187	none	1 in 110, and 1 in 200	28	3	5	...	...	Cemented iron, not hardened.
			3.41	69.41	4.6	0.034	1860 and straight	1 in 100. and 1 in 40	409 and 16	5	...	34.0	34.0	
			5.66	69.41	4.6	0.073	2132; straight and 2722	1 in 110	57	6	5	...	7.5	
			2.53	69.41	4.6	0.025	1860; 3715 and straight	1 in 100, and 1 in 40	450; 50 & 16	4½	...	...	...	Cemented steel, hardened.
10	Kaiserin Elisabeth Railway, Austria	" "	43.87	80.06	4.9	0.351	1244 and 27,905	Partly horizontal, partly gradients of 1 in 100 and 1 in 1175.	13	4½	5	1.0	1.0	Up to the present time no injuries have been observed on these rails.
		Total	1560.29	...	...	12.900								

due time do much good; but by far the most extensive and completely organised society at present devoted to railway interests is the "Association of German Railway Engineers," an association of whose proceedings we propose giving an account in the present and some future articles, believing as we do that the system of making organised investigations, carried out by this body might in many respects be imitated by railway officials in this country, with much advantage to the public and themselves.

The administrative officers of the various German railways constitute together an association of which the engineers form but a section, and at the meetings of this association the advantages and improvements obtained and introduced by each railway are freely communicated to and discussed by the engineers and officials of all railways. Questions on various important matters are put at the annual meetings, and the administrative officers are invited to state their experience and forward their reports within a certain time, while a committee, specially appointed for that purpose, draws up a general report on each question for the next meeting. A series of general reports on various questions relating to railway engineering had thus been prepared for the meeting last year, when that meeting had suddenly to be postponed on account of the Franco-German war; the general reports have, however, been published this year in the journal of the association, and we now propose to lay before our readers an account of some of the chief facts which these reports contain.

One of the first questions dealt with in these reports is as follows: "What are the latest results obtained with respect to the application of the various kinds of steel rails and rails with steel tops; and has any new evidence been obtained with respect to the influence of the notching of the rails on their durability?" The administrations of twelve railways have reported on this question, and from their reports the following results have been deduced.

Rails Made of Puddled Steel.

Of the eight administrations which report on the use of rails made of puddled steel, three state that they have obtained very favourable results, three other administrations express themselves satisfied with their results, whilst the other two railways report most decidedly against the use of such rails; one of these latter administrations attributing, however, the unsatisfactory results to the difficulties connected with the rolling of the peculiar section of rails which they employ.

The administration of the Baden State Railway has determined in future to use, as much as possible, rails made of puddled steel, and the engineers of the Bergisch-Märkisch Railway report that these rails, when carefully manufactured, are very strong and durable. Details of the extent to which these rails have been used on the different lines and particulars of their performance will be found in Table No. I. on the preceding page.

Cemented or Converted Rails.

The officials of three railways only have reported on the results obtained with cemented or converted rails, and from these reports we find that, (1) Cemented rails have been successfully used during the last year on the Altona-Kiel Railway; (2) That such rails have been laid down only once (400 lengths of rail) on the Bergisch-Märkisch Railway, but without giving satisfactory results; and (3) That the Rhenish Railway has used cemented rails with and without a hardened head, have given the best results, none of them having had to be renewed within the same period. Table No. II., on the present page, contains particulars of the results obtained with these rails on the lines just mentioned.

(To be continued.)

EXPLOSIVE COMPOUNDS.

Various Explosives.

(Concluded from page 211.)

In 1866 another application of chlorate of potash was introduced experimentally in England by M. Reichen. It consisted of unsized paper soaked in an aqueous solution of chlorate of potash, charcoal powder, sulphide of antimony and gum. The paper was rolled up under pressure to given diameters, dried and cut up into lengths suitable for rifle or pistol charges. This gunpaper burned with considerable violence in the air, but would hardly explode in small quantities unless in a confined space. We have used this gunpaper with good results in a Snider rifle, and experiments made with it demonstrated its utility, although it never passed beyond the experimental stage. Another of these chlorate compounds has been much pressed upon the Government by its inventor, Mr. Reveley, but without success. This powder is white and consists of the chlorate and yellow prussiate of potash and loaf sugar. Mr. Reveley has constantly made and used it himself in preference to the ordinary gunpowder, but we presume that he cannot find others who have an equal disregard for their own safety as himself, and so the powder has not yet become an article of commerce. It is, however, but a modification of the German white gunpowder tried many years ago without success.

About two years since, Mr. Horsley conceived the idea of mixing nitro-glycerine with his original chlorate powder—that already described. He found that this powder would absorb about 25 per cent.

of nitro-glycerine. In some comparative experiments made with this compound and dynamite, the former was found to be a little stronger than the latter, and not so much affected by a low temperature. A failing point with dynamite is that in very cold weather it is difficult to explode it. Horsley's compound and dynamite have both been cooled down by artificial means to very low temperatures, and whilst the compound was easily exploded the dynamite refused to ignite. This is doubtless due to the small quantity of nitro-glycerine present in Horsley's compound as compared with dynamite. The compound will not explode if lighted by a match in the open air, although it burns more fiercely than either dynamite or gun-cotton do under similar conditions. It explodes at 380°, and has a specific gravity of 1.4. Previously to the outbreak of the Franco-German war it was experimented with by the French Government, the war, however, stopped the experiments which, so far as they were carried out, were highly satisfactory. Its safety under concussion was tested by firing shells loaded with it, and which did not explode. In Norway it is used with continued success in some mines, and it has also had a successful trial in Wales. The safety of Horsley's compound under conditions of storage for any lengthened period has yet to be proved. The material has, however, been stored for nearly two years and is without any change up to the present time. Mr. Horsley has also succeeded in protecting nitro-glycerine by mixing it with finely powdered alum. When required for use—as in manufacturing his compound, or any other—the alum is dissolved out of the nitro-glycerine by water and the pure oil is easily obtained. The alum renders it perfectly safe, and forms the best means of fitting it for transport.

The production of dynamite by Nobel appears to have been the signal for numerous subsequent attempts to utilise the highly dangerous compound nitro-glycerine, some of which have proved successful. The object appears to have been to replace as far as possible the inexplosive silica in M. Nobel's mixture, by explosive materials, thus insuring a greater percentage of power in the resulting compound. It was with this view that Mr. Horsley mixed his original powder with nitro-glycerine, and it was the same object that led Captain Schultze to incorporate the latter ingredient with his gun-sawdust, or wood-powder. This powder is sawdust purified from all resinous substances and digested in a mixture of sulphuric and nitric acids. The result is a feebly explosive material only, which is afterwards strengthened by impregnation with nitrates. This wood-powder Captain Schultze mixed with 17 per cent. of nitro-glycerine, which gave a powerful compound, but one not equal in its results to dynamite. Another method of taming nitro-glycerine has been brought forward by Professor Abel. It consists in granulating gun-cotton and mixing it with saltpetre and as much nitro-glycerine as it will absorb; here the gun-cotton replaces the silica in Nobel's dynamite. With this compound to which Professor Abel has given the name of glyoxiline, some effective blasting and engineering operations have been carried out, but it has not yet found its way into commerce.

Another method of applying nitro-glycerine as a destructive agent has been devised by Professor Engels and was brought prominently before public notice about four months since. This substance produced is termed lithofracteur, and it is composed of nitro-glycerine, with gun-cotton, the constituents of gunpowder, and infusorial earth as the absorbing media. This material has been made and extensively used in Germany for more than two years past, a large factory being in full operation in Cologne. In May last a series of practical experiments were carried out with lithofracteur at some limestone and greenstone quarries in the neighbourhood of Shrewsbury. A detailed report of these experiments appeared in our pages at the time,* so that we need not here do more than refer to them generally. The power of the compound was proved in the workings of the limestone quarries, where some very successful shots were fired in horizontal holes in the face of the rock where powder would not have touched it. In the greenstone quarries some vertical shots proved the applicability of the compound to shaft-sinking in hard ground, its disruptive power under these conditions being very remarkable. It was moreover shown by experiments with loaded rafts, sunk in the river, that for subaqueous operations or torpedoes, lithofracteur was most suitable. Its safety from explosion by concussion was illustrated by throwing a box of cartridges from a height of 150 ft. on to the rocky plateau below, the result being that the box was broken up and the cartridges were scattered but none exploded. In some further experiments made to show its safety in the event of a railway or other collision, cartridges were tied to the buffers of a mineral wagon and it was allowed to run down an incline of 1 in 8 and 500 yards long, being received at the bottom by a stationary wagon. In all cases—for the experiments were repeated—the cartridges were smashed between the buffers and the wagons were smashed between themselves, but no explosion occurred. Like dynamite and safety gun-cotton, lithofracteur only explodes when under conditions of confinement, or when fired in the open air with a percussion fuse. An application has been made to Government to allow this material to be introduced into England upon a commercial scale, and the matter is at present under the consideration of the Home Office.

In order to bring our notice of the progress made in the development of explosive compounds down to the present time it is necessary to refer to two other substances which have been brought forward within the past twelvemonth. The first of these is Pertuiset powder, a French invention, with which some experiments were tried on horses about a year since. The Pertuiset powder was enclosed in bullets and the shattering effects were fully developed upon the skulls, ribs, and legs of the unfortunate targets. The results were communicated to the English Government, but we believe they refused to recognise the material, although we were informed at the time that other European Governments had bought the secret of this barbarous invention.

The second of the two substances to which we have just referred is the picric powder of Professor Abel. The use of nitro-glycerine compounds in shells had been tried with promising results, but inasmuch as confidence in these preparations has not yet been fully established in the army and navy, and as, moreover, the power developed appeared to be in excess of that required, it was necessary to look for another material for shell charges. Professor Abel's investigation of the question resulted in his applying one of the salts of tri-nitro-phenic acid or picric acid to this purpose. This acid is largely produced from phenol or carbolic acid, and forms a cheap and bright yellow dye. The acid itself burns quickly with a brilliant flame, but its salts are all explosive in a greater or less degree and detonate when struck. Professor Abel mixes the ammonium-picrate with saltpetre in certain proportions which forms a bright yellow powder, to which he has given the name of "picric powder." This powder when lighted in the ordinary manner deflagrates very slowly. When, however, the mixture is strongly confined, as in shells, it explodes violently and exerts a destructive action less formidable than that of gun-cotton or dynamite, but greater than that of gunpowder. Some experiments were carried out at Shoeburyness in July last with this powder used in shells, fired from a 9-inch gun. The results, which were recorded by us at the time, although not conclusive, were nevertheless sufficiently satisfactory to justify further experiments with this powder, which appears likely to prove a useful explosive agent for shell charges.

We have now brought our review of the progress made in the development of explosive compounds during the past five years down to the present time. The practical conclusion is that there are several substances—the nitro-glycerine compounds—which, upon the evidence before us as well as from our own observations, appear well adapted for use in engineering and mining operations. At present, these substances are virtually excluded from use by the operations of the Nitro-glycerine Act. The two leading compounds of this class, dynamite and lithofracteur, have been long and largely used with safety on the Continent, and they have also both been made the subjects of searching and satisfactory experiments in England. These facts, coupled with the complaint of quarry proprietors, that substances eminently adapted for their purposes are placed beyond their reach by the above Act, will, it is hoped, operate in obtaining a modification of its more stringent clauses.

* See ENGINEERING, pages 343 and 356, vol. xi.

STEEL IN CANADA.—An establishment under the title of the Viger Patent Steel Works is to be erected on the banks of the St. Charles river.

RANDOM NOTES FROM NORTHERN INDIA.

N.W. PROVINCES, September, 1871.

THIS year's monsoon will long be remembered as one of the most violent on record. From all parts of northern India accounts of unprecedented flood and disasters consequent from them daily pour in. One day we are told that all communication over the Beas river has been broken, and next day the news arrives that the fine bridge which carried the railway over that stream has quite given way. From all parts we hear of broken embankments and flooded lands, villages destroyed by the violence of the rains, bridges either gone or going, railways closed, and the old doolie dâk once more resumed, rivers leaving their beds owing to the bursting of bunds, and cutting out new courses through cultivated lands. For nearly two days the Governor-General and his council were cut off from the country which they govern, as postal and telegraph communication with Simla was quite stopped during that time.

The weir for the new Agra canal, which is under construction at Okhla, near Delhi, has been put to a severe test, as the waters of the Jumna rose far above any previously recorded height, and more than 120,000 cubic feet per second poured over the unfinished weir without damaging that structure. This weir has been watched with much interest as its design is novel, and quite new to the North-West Provinces, it being literally built on the fine sands of the Jumna without foundations. Here it is the custom to sink wells through the loose sands until they reach the solid, and on these as foundations to rest the weir, but in this case it is attempted to save the expense and time necessary for the sinking of these wells, and thus to cheapen and facilitate the construction of the work. The weir itself consists of two parallel walls about 30 ft. apart, protected at the upper and lower sides by great quantities of stone thrown into the river, and packed into regular slopes, the space between the walls being also filled with similar material. This system has been introduced into these provinces by the chief engineer of irrigation, Colonel Greathed.

If, as the home papers would appear to indicate, the old spirit of speculation has revived, and the sluice gates which have so long ponded up the continually accumulating capital in England, have been opened at last, the Indian Government will have let slip an opportunity of borrowing money for their reproductive works, and of securing engineering talent and experience, which this generation may never again see. The canal and State railway projects are still being deliberated on, and so long has this deliberation been prolonged, that public interest in them is dying out, in fact, the State railway hobby, which was lately ridden so hard and violently, is rapidly sharing the fate of its predecessors (hanicks and canals), and soon, if not revived by action, will become a thing of the past.

Mr. W. Sanderson, one of the civil engineers who came to India for Government in 1868, but who has since left the Public Works service, has been engaged for some time in making experiments with the object of trying the possibility of utilising the abundant water power of the Indian hills for the purpose of propelling or hauling trains on light mountain railways up to the various sanataria. The idea is novel, and well deserving of attention. The water power which could be gained in the Himalayan mountains is enormous, as the annual rainfall is so immense, and the facilities for tanking it up in the lakes and gorges of these noble hills are very great. Strange that with such vast burning plains below more attention has not been called to the storing of water in these mountains, and that year after year the 100 or more inches of rain which fall upon these towering peaks should be allowed to pass away uselessly to the ocean. Vast, indeed, is the field which this mighty empire presents to the engineer, and wide and promising is the scope for investment of capital, but somehow indecision and inaction (the offspring of routine and official circumlocution) step in, and cast a dark and discouraging shadow over the pathway of the advancing spirit of progress, and she who should move along with courage and confidence comes with a faltering step and a hesitating manner.

Anxious inquiries are continually being made as to when, if ever, the civil engineers of the P.W.D. are likely to receive an answer to their memorial to the Secretary of State on the subject of their grievances, and, if one may judge by the letters which are continually appearing in the leading journals from these gentlemen, there is no questioning their earnestness and determination to press their claims.

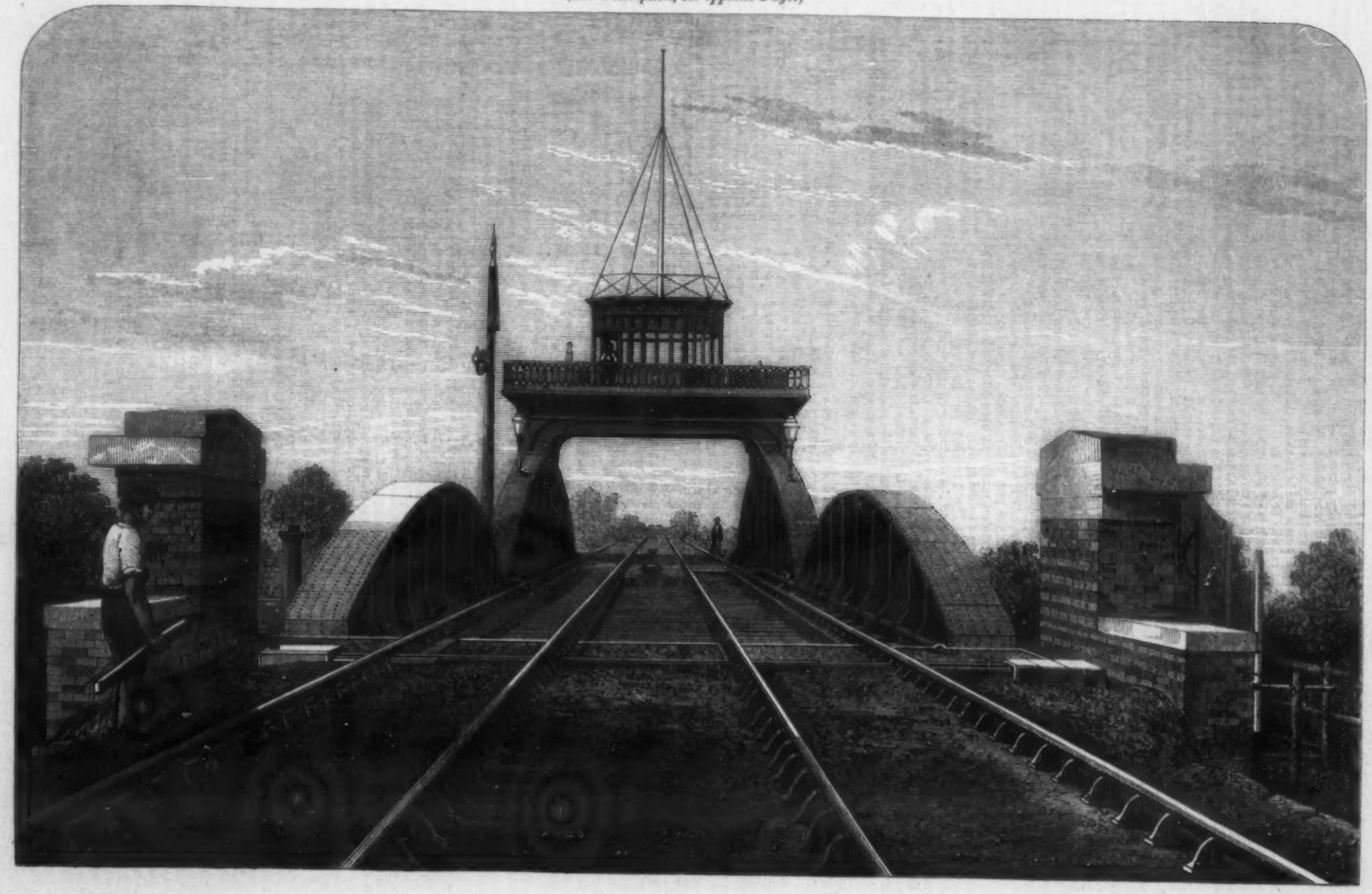
EASTERN OF FRANCE RAILWAY.—The permanent way of portions of this system is being relaid, and on a simpler plan. By this means greater economy and greater security are expected to be secured, while greater facility will also be afforded for the dilatation of the rails. The new system appears to bear some resemblance to that in general use in Great Britain.

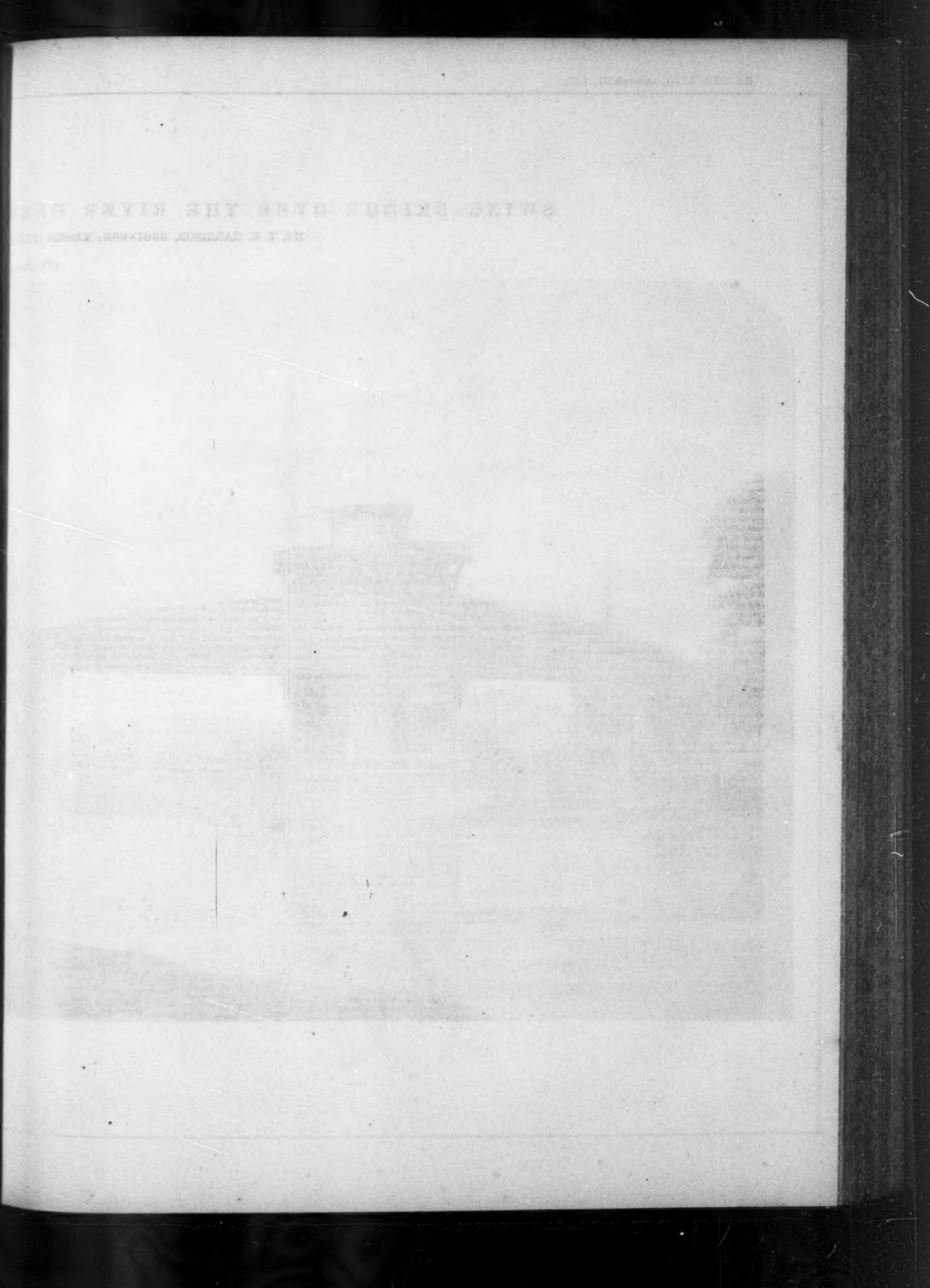
LEROY'S COMPOSITION IN INDIA.—The *Times of India* says:—"It may be an item of consolation for residents or workers under galvanised iron roofs in these parts, to be informed that the Bombay Government has instructed its engineering department to apply Leroy's anti-thermic (non-conducting) composition to sundry roofs of that kind, with a view to test the efficiency of the material as a protection from the fierce sunshine that will be upon us again in a month or two." This is the same non-conducting composition that has been so successfully used for the covering of boilers, steam-pipes, &c.

SWING BRIDGE OVER THE RIVER OUSE; NORTH-EASTERN RAILWAY.

MR. T. E. HARRISON, ENGINEER; MESSRS. PEASE, HUTCHINSON, AND CO., DARLINGTON, CONTRACTORS.

(*For Description, see opposite Page.*)





SWING BRIDGE OVER THE RIVER OUSE

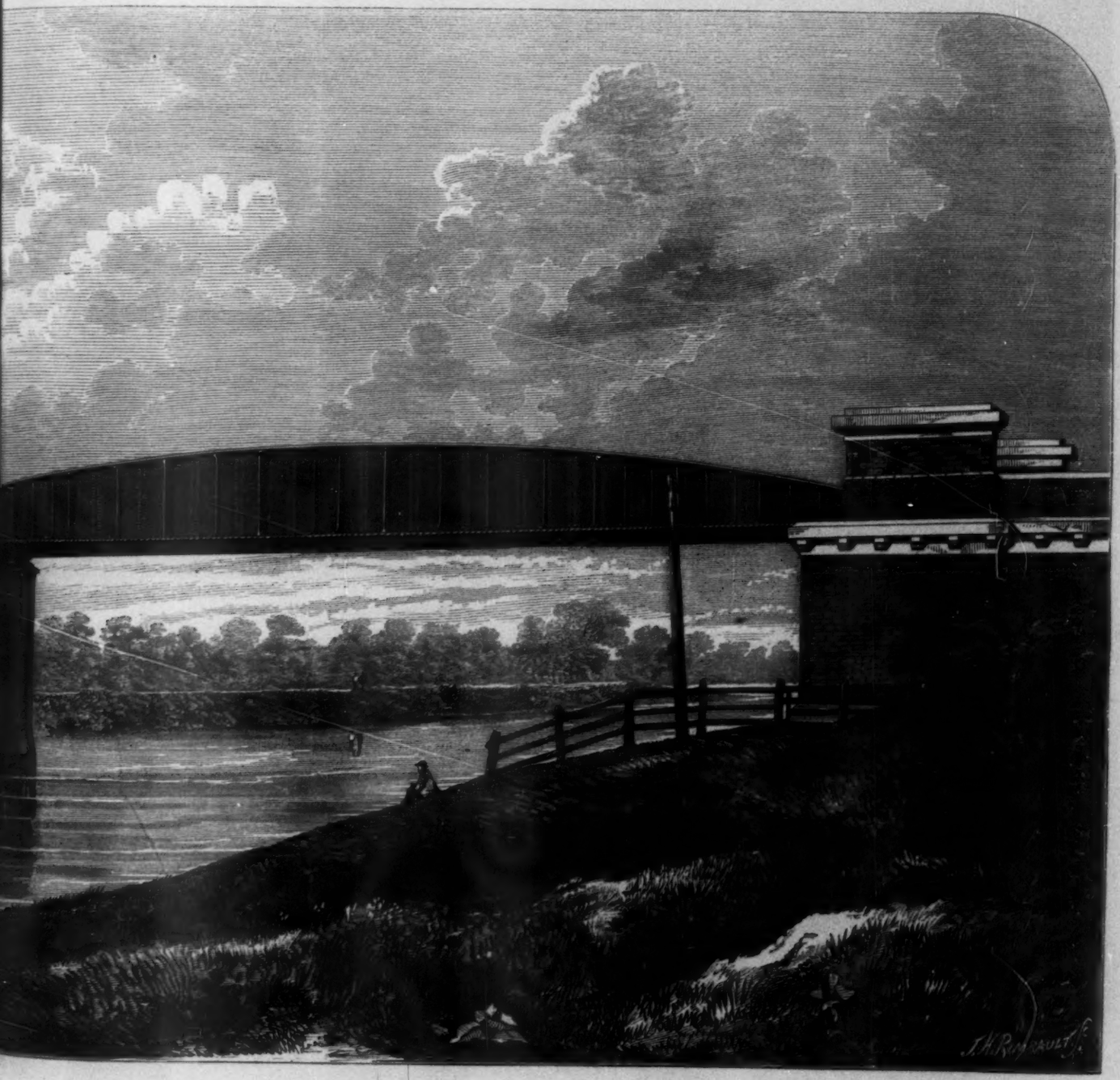
MR. T. E. HARRISON, ENGINEER; MESSRS. PEAR[illegible]TCHI

(For Descr[illegible]n Pa[illegible]

NEAR YORK; NORTH-EASTERN RAILWAY.

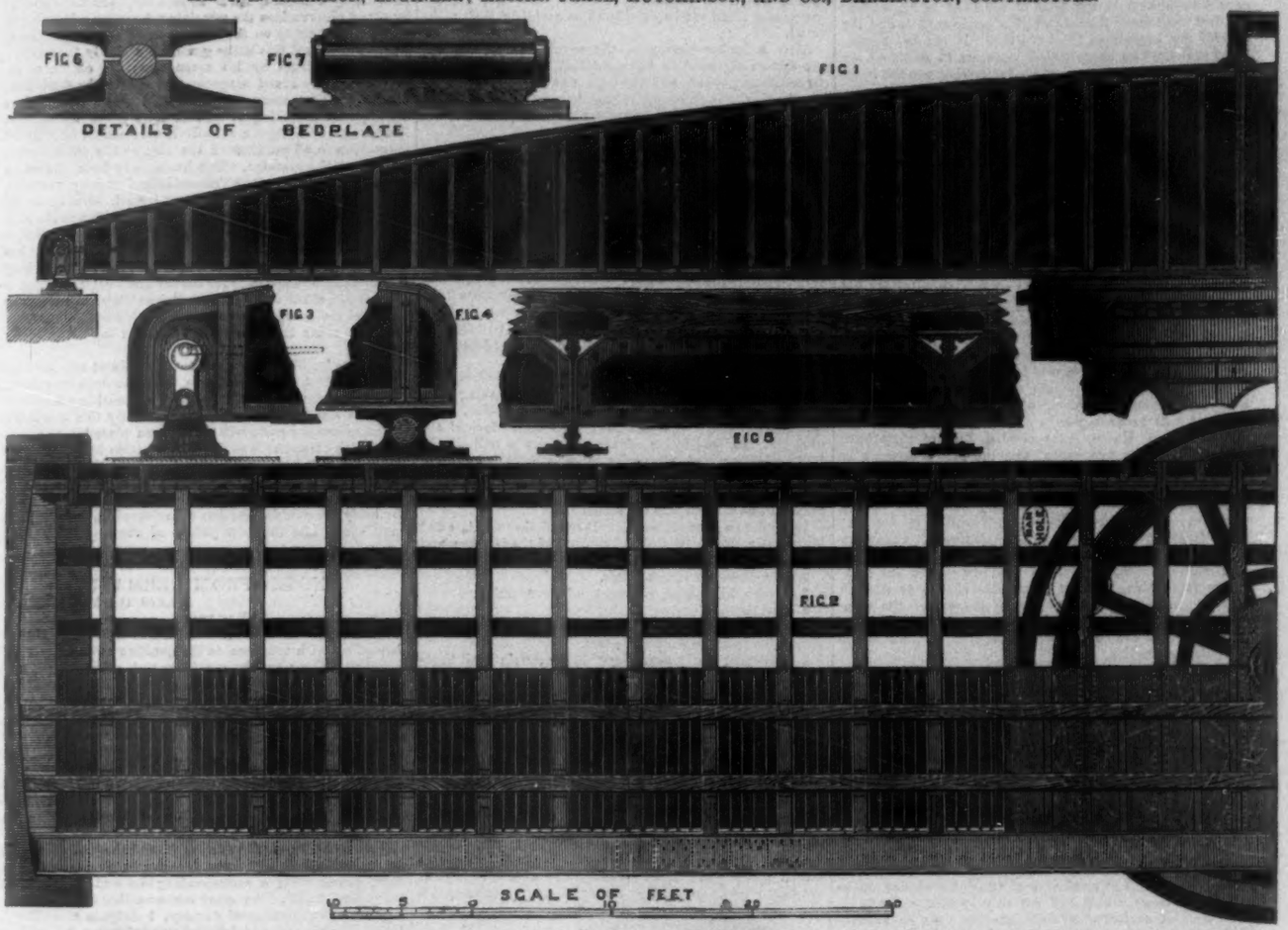
TCHINSON, AND CO., DARLINGTON, CONTRACTORS.

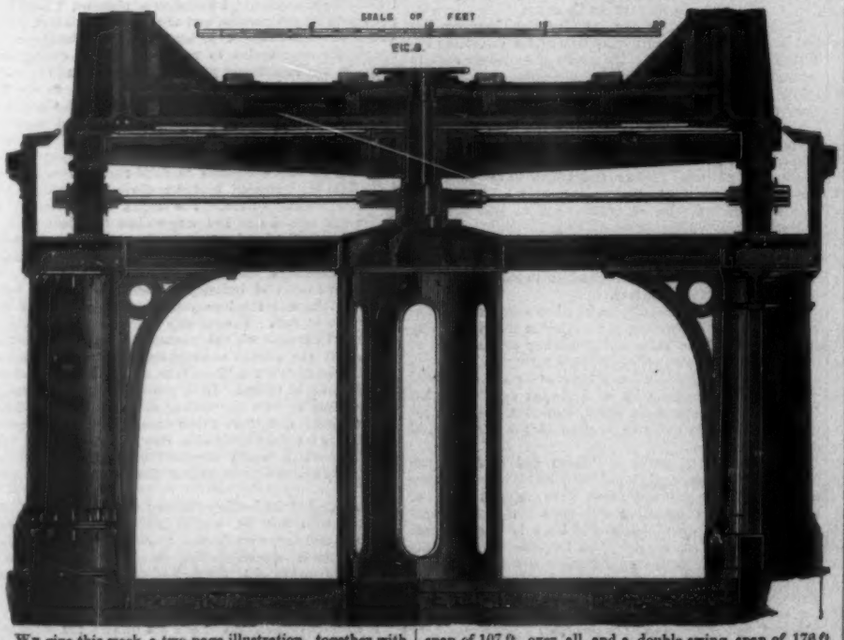
Page 265.)



SWING BRIDGE OVER THE RIVER OUSE; NORTH-EASTERN RAILWAY.

MR. T. E. HARRISON, ENGINEER; MESSRS. PEASE, HUTCHINSON, AND CO., DARLINGTON, CONTRACTORS.





We give this week a two-page illustration, together with other views on the present and opposite pages, of a fine swing bridge, recently completed, and which carries what is now the main line of the North-Eastern Railway, over the River Ouse, at a distance of about three miles from York, a point where the river is navigable for small craft.

The bridge consists of three openings, namely, one fixed span of 107 ft. over all, and a double swing span of 176 ft. over all, leaving a clear opening for vessels of about 62 ft.

The swing portion of the bridge is supported on a pier of cast iron situated on the north bank of the river, this pier being composed of one central column 7 ft. in diameter, containing the hydraulic accumulator, and eight supporting columns each 4 ft. in diameter carrying the roller frame and path. The weight of cast iron in the pier, exclusive of the foundation cylinders, is about 280 tons. A section of this pier is shown by Fig. 8 on the present page.

The swing portion is formed of two main girders 176 ft. in length, and 14 ft. in depth between flanges over the swivel pier, where they are connected together at the top by cross girders, carrying a platform, from which is regulated the working of the bridge. The flooring is composed of 23 transoms 26 ft. long and 1 ft. 8 in. in depth, which, over the pier are covered by ¾ in. plating, the rest of the floor being formed of bars 8 in. by $\frac{7}{16}$ in. with openings of 1 in.

The girders and flooring of the fixed span are of the same form as those of the swing portion. The total weight of wrought iron in both swing and fixed spans collectively is 401 tons.

The swing portion is moved by means of hydraulic machinery giving motion to a pinion geared into a circular rack.

The superstructure of the bridge was constructed and erected to the designs of Mr. J. E. Harrison, of Westminster, by Messrs. Pease, Hutchinson, and Company, of the Skerne Iron Works, Darlington; the hydraulic machinery being supplied by Sir William Armstrong and Co., Newcastle-on-Tyne. At the works of Messrs. Pease, Hutchinson, and Company, to whose London representative, Mr. W. G. Fossick, of 6, Laurence Pountney Hill, we are indebted for the particulars of the Ouse bridge, were also made the remainder of the wrought-iron bridge work on this line of railway, viz. —The River Aire Bridge, one span of 134 ft. and one span of 91 ft.; the Goole Canal Bridge, one span of 135 ft.; the Selby Canal Bridge, one span of 114 ft., and seven other smaller bridges.

Bradford Sewage Works.—At the meeting of the Bradford Town Council yesterday afternoon a tender from Mr. Archibald Neill, of that town, for the execution of the several works required for the defecation of the sewage of the borough, was accepted. It was stated that the amount of the tender was 12,700*l.*, and that there was an addition of 500*l.* for stationary engines and cranes, making a total of 13,200*l.* This was more than 3000*l.* in excess of the sum which it had been stated by those representing the Test Engineering and Sewage Filtration Company, who have entered into an agreement with the Council to defecate the sewage, would be required for the execution of the works, though, as was said, the statement was perhaps the result of a guess, and not of actual estimate.

NOTES FROM PARIS.

Paris, Oct. 23, 1871.

The Janicki Dock.

The new system of Janicki's floating dock, of which we gave a description in our issue of the 22nd of September, was last week made the subject of a paper read before the Société des Ingénieurs Civil of Paris. It will be remembered that the two characteristic elements of this dock are the employment of compressed air for driving out the water from the lower pontoons, and the gaining of stability by lateral floating caissons of automatic mobility.

M. Brüll, the author of the paper, having passed in review the various systems of floating docks, pointed out their extreme cost of construction, and the various difficulties that have been experienced with them. He then proceeded to give a complete description of the new dock. Diagrams and a working model gave every facility to the members at the meeting for understanding the ingenious details of the arrangement. An interesting discussion followed the reading of the paper. M. Mengin, engineer des Ponts et Chaussées, remarked that if the ordinary dry docks cost more in construction, they lasted almost for ever without repairs, and asked what would be the probable duration of the Janicki dock. The reply was, that dry docks could not be constructed suitably in all situations, that variations of temperature and shocks often produced cracks in the floor and sides, and that it was impossible to keep the dock always tight, whilst pumping was always more or less necessary during the repair of vessels. As to floating docks, the three examples in wood at Marseilles, at Bordeaux, and at Havre, were cited. Two of them have been built twenty five years, and the last was made in 1844, and they were still in an efficient state. Iron floating docks will be still more durable, and it is to be hoped that, considering the universal employment of iron in ship building, and the comparatively favourable results that iron docks have shown, that the question of suitability may be considered settled.

The arrangements adopted in this new system are especially favourable, since it is possible always to descend into the interior of the pontoon by the aid of the compressed air, and since it is formed of various independent lengths, which can be detached for repairs, and which are all interchangeable.

M. Flachet, the honorary president, observed, that the great expenses which attended the establishment of dry docks for heavy ships was the most ordinary obstacle that prevented their adoption, that many ports were still deprived of them, and that the new system being economical would find a wide field on this account. But it would, of course, be only possible to adopt it in situations where calm water was available. He considered also it would be found advisable to construct the dock either in a single length, or in sections, firmly connected, in order to avoid the dangers of sectional docks.

M. Maliet mentioned that dry docks in favourable situations have been very economically made. M. Brüll replied that he himself had cited several examples of dry docks for large vessels, which had cost only 16,000*l.* or 20,000*l.*, and that, of course, when circumstances were so favourable, no one would dream of employing floating docks, although their use might be more advantageous than that of dry docks. But those conditions, when the ground was easy to work and could be kept dry, were exceptional.

M. Lavalley, the renowned constructor of the Suez Canal, was disposed to admit the advantages of the new system, but he asked particularly that the reasons of the great economy claimed might be fully explained.

M. Janicki explained that there were two principal causes for the reduction of weight. The compressed-air pontoon, which is only one of the pontoons of the Clark dock recessed, could be made much lighter than the closed pontoons, in which the pressure of water has to be resisted by a heavy bracing. This difference alone in the construction of the pontoon reduces the weight 40 per cent. The abandonment of the heavy side girders, and the substitution of them by the air chambers 6 or 8 ft. high, again reduces the weight by 10 per cent., making the dock only half as heavy as an ordinary floating dock.

M. Dupuy de Lôme, late naval constructor, admitted the advantages to be obtained from the use of compressed air; he saw no objection to construct a dock upon this principle, so as to profit by the reduction of weight which it permitted, but he questioned the wisdom of suppressing the box girders. The pontoon being light, it would be especially necessary to maintain it solidly in the direction of its length, and the girders would be invaluable to give this qualification of rigidity which the pontoon requires. Besides, the space between the lateral walls would serve partly to lift the ship, whilst the lateral floats, by which they are replaced, do not fill this function. He feared, then, that the economy gained by this omission would be purchased at the price of strength, and by the introduction of machinery which would be too delicate. He counselled the inventor to make compressed-air docks, but not to omit the stiffening girders.

M. Brüll, while acknowledging the undoubted authority of M. Dupuy de Lôme, said that when by the employment of compressed air which would effect an economy of 40 per cent., the reduced price would be sufficient to render it possible to construct docks, the girders should be employed, but when, as in many instances, the extra saving involved by not using them was necessary, it was possible, by the adoption of the entire system, to produce a valuable and efficient floating dock. Indeed, M. Janicki obtains longitudinal rigidity by the lattice girders he attaches to the two sides of his dock; he suppresses only much solid plating which he considered unnecessary. Besides, the box girder could not be considered as useful in lifting the vessel.

After a further discussion, the meeting ended, and the new system appeared to have obtained the approbation of the members present, and the hope was expressed that its introduction would permit of the improvement of many ports, without entailing expenses out of proportion to the means available or the advantages derived.

The Isthmus of Suez.

An important work on the piercing the Isthmus of Suez is being published in Paris; it is a detailed description of the works, and of the machinery and plant employed, and of the processes and materials used in the actual construction of the canal. The programme of this book states that its object is to detail and reproduce by its drawings all the technical elements which were introduced in the progress of the work. This is the first time that these elements have been thus grouped, the numerous volumes which have already been published bearing on the political, picturesque, or commercial aspects of the work of M. Ferdinand de Lesseps.

It is M. L. Monteil, engineer of the Suez Canal Company, who has been attached to the gigantic undertaking since eleven years, who has undertaken this publication. The text will be as concise as possible; with the history of the work and the description of the drawings it will give in detail all prices, and the performance of each item of the plant. There will be 300 plates engraved on copper, giving drawings in detail of the works and the machinery. The work will be divided into ten series.

1. Towns and encampments. Plans of the maritime and fresh-water canals. Geological sections of the isthmus, and profiles of the ship canal.
2. Distribution of fresh water.
3. Jetties, lighthouse, and works of construction.
4. Services of Transport.
5. The small dredging machines; the application of the endless bands and spoil distributors.
6. Dredging machines employed in the canal; spoil boats and lighters.
7. Dredging machines, elevators, &c.
8. Dry cuttings. Wagon and engine shops.
9. Repair shops.
10. Materials for maintenance and lighting.

It will be seen that it promises to be a considerable work. All the materials for the text and the plates are ready, and at present they are being prepared for publication. This work, which will confer lasting honour on its author, is intended to render special service to those engineers who may be called upon to study or carry out great undertakings of public interest analogous to the Suez Canal. But it will interest all those who wish to appreciate the efforts made unceasingly during fifteen years to open a new route to the commerce of the world.

A Compensating Compass.

M. Arson, engineer to the Parisian Gas Company, has just invented a compensating apparatus for correcting the deviation of the compass. The needle of course does not in general indicate the position of the magnetic north. It is affected by the masses of iron entering into the construction, the armament, or the cargo of the ship. These deviations, which were very feeble in the time of wooden sailing vessels, have become more and more considerable, in proportion as iron has been more largely used in the hulls of ships, as powerful engines and boilers have been introduced, as armour plates of ever-increasing thickness have been added to the sides of vessels, and as iron has been utilised for masts and rigging. There are cases where the magnetic influence of the ship so overbalances that of the earth, that although the position of the compass is chosen with the greatest care, it is impossible to obtain much information from its indications.

The means most generally employed to escape this inconvenience consist in checking the deviation of the needle by the influence of the ship, and preparing either tables of corrections or a curve, called Napier's curve, the inspection of which allows the deduction of the true from the observed variations. This estimation of deviation entails a rather long and delicate operation, which, moreover, has to be repeated for different latitudes, to allow for the alterations of magnetic influence.

The mathematical works of Poisson and of Airy have furnished, it is true, analyses of complicated magnetic phenomena, and many investigators have proposed means of compensating the deviating influences. But navigators have shown in general little confidence in these various systems, because all would require frequent changes in the position of the magnets, or of the masses of iron which serve for compensation; and these changes involve operations so delicate, and an incertitude so great, that it is preferred to put confidence in a compass which is supposed to be compensated, and which is more or less true.

The masses of iron in a ship act in two manners on the needle of the compass, first by their permanent magnetism, and then by the induced magnetism that they take under the influence of the earth. The first effect is constant, and comparatively easy to subdue. The second varies with the position of the ship, and can be compensated only by a movable needle.

The uncertainty of the moving compensators involves, in the port of departure, the correction of the deviation of the compass by a magnet, as far as possible, then ascertaining by direct observations the remaining deviations, in order to place their quantity on the table or on the curves of correction. At present this is the general practice in the navy.

M. Arson hopes by his arrangement to obtain exact compensation. Fixed magnets compensate the deviations due to the permanent magnetism. Bundles of soft iron wire placed according to certain laws given by calculations, ought to compensate the deviations caused by induced magnetism in all positions of the ship and in all latitudes. The proposed apparatus, which has already been applied on one of the steamers of the Transatlantic Company, contains, besides the ordinary card, a second card, serving as an indicator. When it is wished to follow a given route, this latter card is traced by means of a wheel until it indicates the desired angle. Now by this movement the operator has placed the packets of soft iron into the position in which they are required to compensate for the deviation corresponding to the position of the ship. It is sufficient, then, to adjust the needle of the compass to the same angle which has been given, in order that the route indicated may be actually followed.

Conversely, if it be wished to ascertain at any moment the route which the ship follows, it can be done by moving the wheel before mentioned until the repeating circle indicates the same angle as the compass. By this movement the compensating parts will have been placed in the position which corresponds to the compensation in the azimuth where the vessel is; the angle observed will be the true angle of the route.

If the results sought can be obtained, they will be obviously invaluable. Seamen experienced in these difficult questions will be the best judges of the apparatus of M. Arson.

NOTES FROM GERMANY.

Berlin, October 23, 1871.

Railways.

At the present time two important difficulties present themselves with reference to the question of railway management. These are the great want of rolling stock and the frequent recurrence of accidents. With reference to the first point we may mention, that the steady increase of traffic upon German railways till 1866, fell off after that year, and it was only at the commencement of 1870 that it again began to assume its former proportions. The breaking out of the war, of course again checked the railway business, the line being absorbed by the endless requirements of the army. And later, the transport of the returning forces threw great and special labours upon the various companies. The transport of an army corps requires 100 trains of 250 tons each, and the time occupied by the train in going to and fro may be averaged at ten days, representing a corresponding loss and hindrance to the general traffic. An army corps consists of 8 infantry regiments, 5 regiments of cavalry, 1 brigade of artillery, 1 battalion of chasseurs, 1 battalion of pioneers, 1 battalion train with its equipments, and the field ambulances, being a total of 32,000 men, 6000 horses, and their baggage. Of course the interruption to the traffic varied during and after the war in different parts of Germany, and the traffic from north to south, from the maritime towns to the interior, increased to such an extent that the available rolling stock was found quite inadequate. Great and constant orders for the construction of wagons, carriages, and engines are given out, but at present, it is impossible for the different manufacturers to fulfil their orders, and the difficulties are increased by the cession of the Alsace and Lorraine railway system. The largest wagon factory at Berlin has turned out 400 wagons less than last year, a result due to the deficiency of workmen, and to the difficulties experienced in obtaining wheels and axles from the manufacturers, who have also been short handed. In this latter branch of industry the want of hands is very severely felt, and the inconvenience is increased by the high price of coal. The railway companies are anticipating the fulfilment of the various contracts for rolling stock with the utmost anxiety, and an amalgamation of railway interests is considered to be advisable for improving the condition of things. It is, proposed also, to encourage the builders to hire out rolling stock to the companies which would undertake to purchase them subsequently, and also to maintain on hand a very large amount of rolling stock, which would be rented or purchased on terms sufficiently favourable to answer the manufacturers' purpose.

A meeting of the leading railway men, traffic managers, &c., has been held in which this question, and many other kindred ones were discussed, and a careful comparison has been made between the English and German systems of working, showing that the former possesses great advantages over the latter.

Wire Rope Navigation.

It appears that serious efforts are being made to extend the use of the submerged wire rope system for river and canal navigation. The company formed for this purpose has received concessions from the Prussian Government, and other Governments will doubtless grant similar privileges. The estimated cost per mile is under 500*l.*, and a diminution

of 25 or 30 per cent. in the cost of water carriage is anticipated. If these results be achieved a large amount of traffic will be obtained, which is now transported by the railways.

Railway Wagon Building.

The large establishment for the manufacturing of railway wagons of Deicke, at Brunswick, has been purchased by the bankers, Messrs. M. J. Frenadorf and Co., at Hanover, and is now formed into a joint stock company, of which the Counsellor of Commerce of Voigtlander, and Mr. Urbich, of Brunswick, are the directors. The capital of the company is 1,312,500 francs, of which 562,500 francs are to be first subscribed, and the shares are being well taken. The company takes over the works including all the contracts in progress, and they propose so to enlarge the establishment as to turn out 1000 wagons yearly.

Salt Mines in Germany.

The production of salt in Germany has during the last ten years, increased vastly, owing to the development of many new mines. In fact, at present, the country is exporting salt in large quantities instead of being, as formerly, a considerable importer of the commodity.

The official statistics for the years 1860-69 will be of interest, as they give a statement of the increase in the production.

	Rock salt. tons.	Common salt. tons.	Total. tons.
1860	51,167	252,679	303,846
1861	50,068	275,829	325,897
1862	85,105	280,333	365,438
1863	135,625	278,006	413,631
1864	204,687	283,380	488,067
1865	172,171	281,208	453,379
1866	240,023	280,967	520,990
1867	275,974	278,188	554,162
1868	318,866	266,951	585,817
1869	355,931	280,624	636,555

Thus, from 1860 to 1869, it will be seen that the salt production increased 110 per cent., chiefly from the extension of the rock salt mines amounting to 594 per cent., the increase of common salt being insignificant.

The principal rock salt deposits are in Prussia, Anhalt, Bavaria, and Wurtemburg, there being 7 mines occupying 1587 workmen. In Prussia three works produced in 1869 177,950 tons, the total being divided between the mines at Stassfurt 16,306 tons, those at Erfurt 12,580, and those at Stettin (Hohenzollern) 2360 tons. The Anhalt salt bed situated near Stassfurt yielded in the same year 131,084 tons, and that in Berchtesgaden (Bavaria), yielded 6497 tons, and in Wurtemburg the Wilhelmsglück and Friedrichshall Works gave 39,860 tons.

The value of rock salt amounted to 3,995,630 francs on the works, approximately 11 francs per ton.

In 1869 there were 58 common salt mines, occupying 2977 miners, and producing 280,624 tons, representing a value of 9,269,557 francs, the price approximating to 33 francs a ton at the works. Thirty-three mines belonged to Prussia, yielding 170,019 tons, equal to 60.5 per cent. of the whole. Bavaria possesses 4 mines, yielding 41,911 tons; Wurtemburg 4, yielding 21,000 tons; Baden 2, yielding 14,928; Hesse 3, yielding 12,160 tons; Thuringia 7, yielding 13,997 tons; Mecklenburgh 1, yielding 1296 tons, Brunswick 1, yielding 2859 tons; Anhalt 1, yielding 1417 tons, and Lippe 1, yielding 1046 tons.

At least 72,243 tons of common salt were exported in 1869 from the German customs abroad: Hamburg received 50,156 tons, Austria 7715 tons, Bremen 6478 tons, the Netherlands 4520 tons, Switzerland 904 tons, the Baltic Provinces 418 tons, Geestemunde 1040 tons. On the other hand 52,029 tons of common salt were imported, of which 41,897 tons paid a heavy duty, the rest entered free. From England, Spain, and Portugal, came 23,994 tons, from France 9595 tons, from Switzerland 2709 tons, from Belgium 1674 tons, from the Netherlands 1367 tons, &c. The statistics show that of the whole amount 91.4 per cent. is of home production, and 8.6 per cent. are imported. Since 1860 the consumption of salt has more than doubled, the augmentation being chiefly due to the larger use of the material in industrial pursuits.

Mining Casualties.

During the year 1870, there occurred 402 fatal accidents in the various Prussian mines, divided as follows: in one accident, 35 miners lost their lives, in two accidents, 12 were killed, in three, there were 9 deaths, 13 were attended with 26 fatal casualties, and 383 accidents caused each one death. There were thus 465 miners killed during the year, equal to 2.55 per thousand, the total number of workmen being 183,532, whilst the average of 1869 showed 2.340 deaths per thousand. At the mines of New Iserbohn, near Dortmund, 35 men were killed by firedamp. The larger number of accidents, however, were caused by the falling of material; through this, 154 fatal casualties happened. One hundred and three shaft casualties are recorded; amongst them, 47 men were killed by falling, and 32 in descending into the mines. Out of the latter number, 8 were killed on the man engine, 7 in the act of descending by the usual means, and 10 in descending in an improper manner. Besides the 35 deaths caused by firedamp at one accident, 7 were killed in one explosion, 4 in one accident, 8 in two, and 1 man in each of several others. In the process of blasting, 14 workmen were destroyed, and 42 were killed on different inclined planes, 24 of them became entangled in the lifting gear, and 18 died through accident with the machinery itself. In hauling underground, 8 men were killed, and 12 were suffocated by choke-damp. In coal mines, 339 men, or 0.146 per thousand were killed; in lignite working, 41 men, or 2.774 per thousand; in mining ores, 79 miners, or 1.458 per thousand were killed; and in the getting of other minerals, 10 men, or 1.685 per thousand, lost their lives.

Distributing these casualties according to the quantity and value of the mineral raised, we find that in coal mines there was 1 death to each 68,534 tons raised, equivalent to a value of 570,166 francs; in the lignite mines, 1 to every 149,488 tons, equal to 527,527 francs; and in the iron and other mines 1 life was lost to every 98,499 tons raised, worth 984,010 francs.

Or, collectively, 1 life was lost for every 70,922 tons, of an average value of 737,930 francs.

The fatal accidents were distributed in the following manner:

At the chief mining bureau	Breslau	94 or 2.25 per 1000	
"	"	Halle	59 or 2.098 "
"	"	Dortmund	206 or 3.666 "
"	"	Bonn	114 or 1.97 "
"	"	Saarthal	17 or 1.777 "

Telegraphs during the War.

On the 18th of February last year there were established by the German State Telegraph organisation 6548 miles of telegraphs on the theatre of war in France extending over 2736 miles of distance, in addition to the telegraph lines set up by the field telegraph force. The greater part of this was newly constructed, and the remainder consisted of portions of the partially destroyed French system reorganised. In February the German telegraph *réseau* extended (excepting the principal lines to and around Paris) on the north to St. Quentin, Amiens, Rouen, and Dieppe; on the west to Alençon, Le Mans, and Tours: on the south to Blois, Orleans, Gien, Auxerre, Dôle, Delle, &c., the most advanced station having been previously occupied by the telegraph staff. But besides this special amplification of the telegraph *réseau* in France a considerable extension of the system was also necessary in Germany, and connected with it new stations on the North Sea and Baltic coasts. The length of lines laid for this purpose amounted to 1702 miles, extending over a length of 704 miles, and connected with 47 new stations.

During the war 1860 telegraph stations in Germany and 34 in France were employed by the Germans for the dissemination of war news.

Coal in the Aleutian Islands.—A company of San Francisco capitalists has been incorporated to work coal in the Aleutian islands. The capital has been fixed at 500,000 dols.

The Opening of Queen Victoria-street.—The new thoroughfare leading from the Victoria Embankment at Blackfriars Bridge to the Mansion House will be formally opened by the Metropolitan Board of Works, with some little ceremony, on Saturday, the 4th November next. This street, a portion of which has for some time past been open to the public, will complete the line of communication between Westminster and the City.

The Late Mr. Charles Babbage.—The death of this philosopher, at the advanced age of nearly eighty years, was recorded last week. Born on December 26th, 1792, Mr. Babbage received the preliminary education at a private school which introduced him to his college career, and in 1814 he obtained his Bachelor's degree at Cambridge. During his residence at college he was honorably associated with Sir John Herschel and others in the endeavour to introduce various important reforms in mathematical systems borrowed from the Continent, and it was the pursuit of this object that gradually led him up to the great and never-completed work of his life, upon which his popular reputation stands. He designed and partly completed a calculating machine of far greater scope than had been dreamed of by Pascal, Thomas, Shütz, and others. The first scheme, that of the difference engine, was afterwards absorbed by the grand idea of the analytical engine. But Government, who had countenanced the first scheme, did not see the policy of being led into the unknown expense which would probably attend the construction of the analytical machine, so they abandoned Mr. Babbage, and, it must be owned with somewhat questionable taste, made him a present of the work he had already done. This offer was, however, refused, and the unfinished machine, with mountains of plans and memoranda, found their way into King's College in 1843. Excepting in relation to this machine, and to street music, Mr. Babbage had no hold upon the popular mind. Yet he wrote much, more than eighty books and pamphlets having issued from his pen. In public life Mr. Babbage made little mark; for eleven years he held the chair of the Lucasian Professorship of Mathematics at Cambridge, and on one occasion, in 1832, he presented himself as a candidate for Finsbury at the general election, but without success. One of the most useful works of his life was the production of his Tables of Logarithms, now more than forty years ago, and which found wide favour here and abroad. Half a century since Mr. Babbage assisted at the founding of the Astronomical Society, he was one of the oldest members of the Royal Society, and belonged also to others of the leading learned societies in London and Edinburgh.

IRRIGATION WORKS AT LEAMINGTON.

On Monday the chairman of the Leamington Board of Health formally opened the sewage irrigation works which have been constructed in the town at a cost of 16,000*l.* The magnitude of the works and of Lord Warwick's irrigation farm (the latter is intended to include 1000 acres) has excited considerable interest in the county. The two condensing rotary beam engines erected at the pumping station are 150 horse power each, and either will pump 1,500,000 gallons in twelve hours. The steam cylinders are each 36 in. in diameter, and the pistons have a stroke of 8 ft.; the fly-wheel is 24 ft. in diameter. The beams weigh upwards of 15 tons each. The pumps are 26 in. in diameter and 5 ft. stroke. Steam is supplied by three Lancashire boilers, each 24 ft. long by 7 ft. in diameter. The rising main, 18 in. in diameter, is 2¼ miles long. The engine house is in the modern Italian style, and is 70 ft. by 30 ft., 55 ft. high, the foundations being 26 ft. deep. At the preliminary trial one engine pumped 20,000 gallons of sewage in an hour and a half, working 10½ strokes per minute, with a recorded pressure of 60 lb. per inch on the boiler. The population of the district at the last census was 23,429; and in ordinary weather one pair of pumps will exhaust the whole of the sewage by working four hours a day. The engines and boilers cost nearly 5,000*l.* Fortunately for the town the Board were not put to the expense of purchasing land for irrigation purposes. After various negotiations the Earl of Warwick undertook to dispose of the sewage for a term of thirty years. In consideration of his lordship paying 450*l.* a year towards the pumping expenses, the Local Board agreed to erect, at their own cost, engines, main, &c., and to pump the sewage on to his lordship's estate, the highest altitude to which it is to be pumped being 153 ft. The irrigation farm has been prepared by Mr Clifford, who has had considerable experience in such matters. Many acres have already been sown with Italian rye grass, &c. A model cattle house has been erected for the accommodation of several hundred head of stock, and many of the stalls are already filled, milch cows forming an important item in the herds. Supplies of crops and fat beasts are to be sent to the metropolitan and other markets. Mr. Tough, formerly of the Dorking Sewage Farm, has charge of the husbandry department. This, if not the largest sewage farm in the country, will in all respects be a model, Lord Warwick having spared no labour or expense in order to test the principle of utilising sewage by means of irrigation.—*Pall Mall Gazette.*

BROADWELL'S MITRAILLEUSE CARRIAGE.

Mr. Lewis W. Broadwell, of Vienna, has recently designed a new form of carriage adapted for mul iple guns, and involving several important modifications. We have on previous occasions referred to Mr. Broadwell's inventions in connexion with the Gatling and similar guns. The advantages he has sought to combine in this carriage are such as will secure an arrangement of bearing parts so that the gun may be better balanced than in ordinary carriages. It likewise includes an apparatus for maintaining an automatic right and left-hand movement of the barrels for horizontal firing, and also a shield for protecting the gunners when in action, and serving as a seat at other times.

The axle of the main frame which is mounted upon wheels supports an angle and plate iron frame to hold the trunnions of the gun, and to admit of the barrels being elevated or depressed by a screw at the rear. The trunnion plate is pierced at or about its centre for the reception of a pin or perch bolt, which is kept in place by passing through a bottom plate fitted underneath. This plate is carried to the rear, where it is provided with a curved slot, or with a curved plate through which a pin on the bottom of the breech piece or ring passes, the radius of the curve being struck from the perch bolt so that the barrels can be directed laterally to the right or to the left as desired for divergent firing, and without in any way interfering with the elevation for distance firing. This plate has a projecting piece for supporting a vertical pin or standard to which a spring clutch or disengaging apparatus is fitted, the prongs or fork of the clutch taking into a double endless screw on the crank shaft which determines the loading and firing operations. By this means when the clutch is engaged and the crank shaft rotated an automatic right and left motion of the barrels takes place as well as the continuous loading and firing of the charges. There is a tightening nut and disc on the end of the shaft, and the disc is formed with a conical collar to fit in a corresponding recess in the screw. These when pressed together compel the two to partake of the same movement, otherwise the screw is loose upon the shaft and remains idle. By this means the gunner in charge can in an instant direct the bullets in any direction, right or left, or straight ahead, by simply loosening the disc, or if the disc is left fastened a continuous right and left motion continues so long as the shaft is turned. Instead of the disc a rising and falling lever may be used, and the ends of the screw may be shaped to alter the angle of the fork or clutch for reversing the stroke at the end of each travel. The fore end of the gun or frame is provided with a folding shield (bullet proof), the flaps of which can be raised or lowered to form seats for the men when travelling; or fixed in position by catch hooks, for action.

In the drawings Fig. 1 represents a side elevation of a mitrailleuse, with one of the wheels removed to show the parts more clearly; Fig. 2 is a transverse section of the gun taken just in front of the axle and trunnions; Fig. 3 is a detached edge view of the shield; and Fig. 4 are details of the traversing mechanism.

The axle, *a*, mounted upon wheels, *b*, *b*, has at its central part the bearings, *d*, *d*, of the trail, *e*, composed of angle and plate iron, *f*, *g*, for supporting a socket or bed plate, *h*, in which the trunnions, *i*, *i*, of the gun are held, the trunnions being part of a recessed strap, *j*, through which the perch bolt, *k*, passes to hold the gun, *l*, in position as on a pivot, the

BROADWELL'S CARRIAGE FOR MULTIPLE GUNS.

FIG. 1.

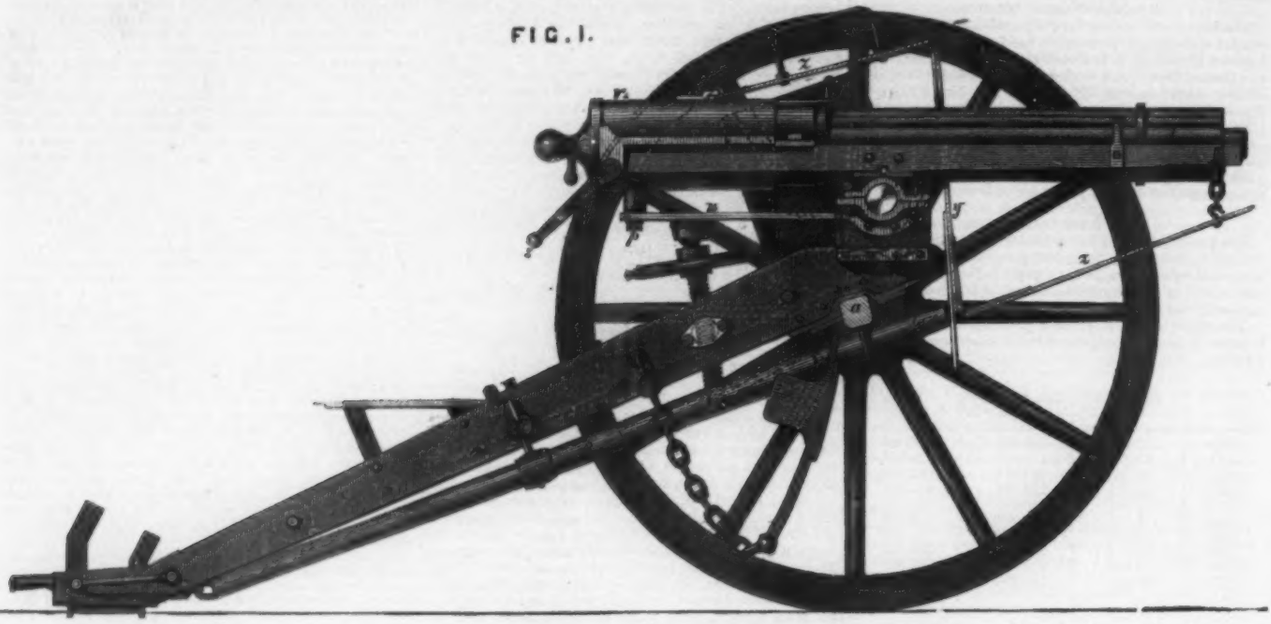


FIG. 7.

FIG. 3.

FIG. 2.

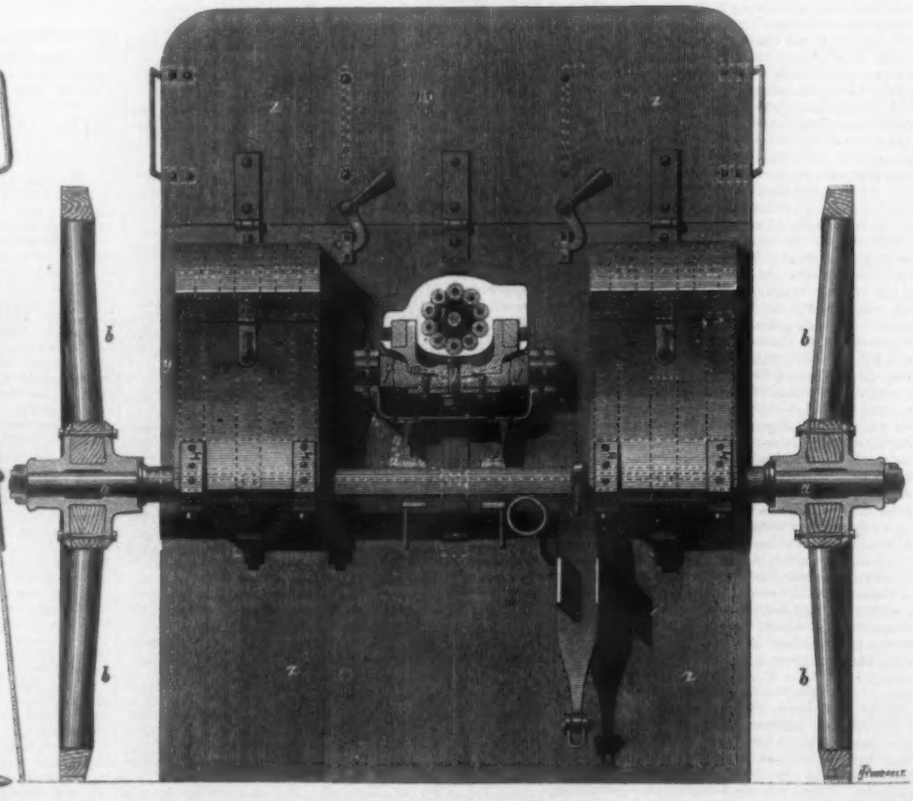


FIG. 5.

FIG. 4.

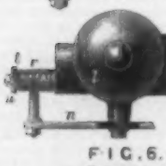
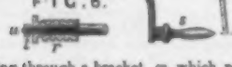


FIG. 6.

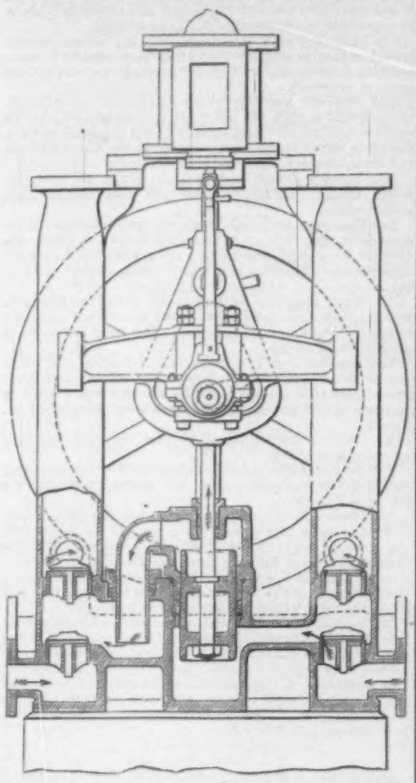


bolt, *k*, also passing through a bracket, *m*, which rests upon the strap, *j*. Below the strap, *j*, a plate, *n*, is bolted, the after end, *o*, of which is slotted for a pin, *p*, under the breech portion of the gun to slide to and fro in when the automatic traversing motion is being transmitted to it by the clutch, *q*, riding in the threads of the double endless screw-threaded collar, *r*, the collar being on the spindle of the breech block rotating mechanism, so that it partakes of the movement of the crank handle, *s*. The rotation of the collar, *r*, with the spindle is controlled by a screw button, *t*, on the end of the spindle, the button having a conical face to enable it when turned to approach the collar to bind itself by the nut, *u*, on the extreme end of the spindle so as to hold it secure. The top of the breech portion, *v*, is shaped to receive a drum of cartridges such as we described in the eleventh volume of ENGINEERING, page 379, and the trail is so arranged that additional drums can be carried in the boxes, *w*, *w*, which are mounted upon the main axle, *a*, so that a continuous fire can be kept up, the boxes being arranged so as not to interfere with the working of the gun. The boxes are fitted to straps, *x*, which have projecting lugs for supporting the central plate of a shield, *y*, which stretches across and almost fills up the space between the wheels, *b*, *b*, for the purpose of protecting the gunners at the rear who may be manipulating the mechanism and directing the gun. This central plate, *y*, is a fixture, and has at top and bottom other plates, *z*, *z*, hinged to it, the lower one of which reaches down to the ground to protect the legs of the men, and the upper one reaches above their heads and protects the upper parts of their bodies and heads. The top plate is provided with clip hooks which fall into eyes on the central plate, and these hold it firmly when in a vertical position, as will be seen by reference to Figs. 2 and 3. On unhooking the clips the top plate can be laid over for its edge to rest upon the top of the gun, as seen in Fig. 1, where it forms a seat for the gunners when travelling over the field or from place to place. The lower plate can be turned up towards the muzzles of the barrels and there retained by hooking it to a short chain provided for the purpose. This lower plate when turned up forms a foot or resting plate for the feet of the men, and they are prevented falling from the seat by hand rails, which are fitted on the top plate or seat.

RECENT PATENTS.

The following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 2972, 10d.) Richard Potter Pearn and Frank Kelsey Pearn, of Manchester, patent the arrangements of double-acting steam pump shown by the annexed sketch. In this pump there is a stuffing box at the middle of the



length of the pump barrel through which a plunger works, this plunger displacing the water from the upper and lower parts of the barrel alternately. The stuffing box just mentioned is arranged so as to be readily accessible and so that it may be re-packed without removing any working parts.

(No. 2981, 4d.) Richard Hill, Albert Thomas Ward, and Carl Friedrich Claus, of Middlesbro'-on-Tees, patent a mode of annealing wire by immersing it in a bath of some flux raised to the necessary temperature, this flux being of such a nature that when the wire is withdrawn from the bath it will adhere to the wire and form a coating which will protect the latter from oxidation, while at the same time it can, when the wire is cold, be readily removed by washing. Amongst the substances mentioned as available for making such a bath as that just referred to are chloride of calcium, hydrate of soda, and a mixture of chloride of sodium with lime or chalk. The object of this mode of annealing, which appears to be a very promising one, is to avoid the oxidation of the wire which takes place on the ordinary system, and hence to enable the process of washing with acids to be dispensed with.

(No. 2986, 10d.) James Davidson, of Ludenham, patents machinery in which rollers or segmental surfaces armed with projecting points are employed to break up cakes of gunpowder composition for the purpose of producing "pebble' powder.

(No. 2993, 6d.) Thomas Hitchcock, of Stamford, patents "an improved machine for producing or multiplying motive power by means of a combination of levers acting on a fly-wheel"! This is another of those absurd patented contrivances which so frequently crop up to disgrace the mechanical knowledge of the nineteenth century and the management of our Patent Office.

(No. 2994, 8d.) Thomas Williamson, of Staleybridge, patents an arrangement of indicator which we could scarcely describe clearly without the aid of drawings, but which we cannot but regard as objectionable. The indicator appears to us unfitted for taking diagrams for any but very slow moving engines.

(No. 3009, 8d.) Jonathan Pickering, of Stockton-on-Tees, patents arrangements of epicycloidal gearing applicable to palleys or winches, &c. We are rather doubtful concerning the novelty of these plans.

(No. 3015, 1s. 4d.) Edmund Alfred Pontifex and John Barton, of Shoe-lane, patent arrangements for enabling centrifugal drying machines to be worked continuously without being stopped for being filled or discharged. According to these plans the cylinder or basket of the machine is inverted or placed with the open end downward, and it is fitted with a centrifugal feeder to supply the materials to it while in motion, and with an arrangement of discharging scoops for removing the materials when dried.

(No. 3021, 10d.) Julius Frölich, of 10, Hounsfield-road, Sheffield, patents constructing gas furnaces (in which air is passed fuel to produce carbonic oxide, which is then burnt by a further admission of air) with a wagon or equivalent movable part to form the bottom of the fuel chamber.

(No. 3029, 6s. 8d.) Allen Ransome, of King's-road, Chelsea, patents a number of arrangements of wood working machines, including the box maker's saw, the multiple-spoke shaping machine, and the sleeper adzing and boring machine illustrated and described by us on pages 63 and 86 of our last volume. Of the other machines included in this specification we may have something to say on a future occasion.

(No. 3039, 8d.) James William Butler, of Stonebridge-park, Willesden, patents the system of artificial stone caissons for foundations of which we gave an account on page 306 of our last volume.

(No. 3043, 6d.) Edward Langlet, of Schaerbeck, Belgium, patents what he terms "an apparatus for preventing boiler explosions," but which is really merely a contrivance for admitting steam to an injector or donkey pump when the water in a boiler becomes low. The apparatus consists of a balanced float provided with a spindle which is attached to an equilibrium piston valve opening inwards. On the float falling the valve is opened and steam admitted to the injector or donkey pump when—if the injector or pump happens to start properly on the steam being turned on—a supply of water will be furnished to the boiler. We cannot regard the apparatus as reliable.

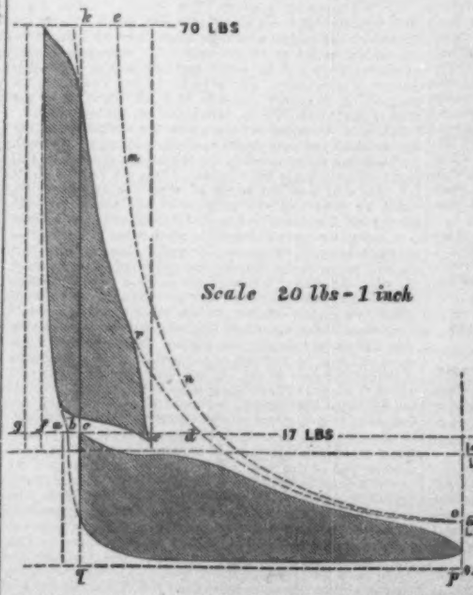
(No. 3049, 8d.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of William Craig, of Newark, and Henry Lefferts Brevoort, of Brooklyn, U.S., an arrangement of condenser for steam pumps, intended to enable a vacuum to be formed behind the piston and the exhaust steam to be admitted to the suction for the purpose of warming the water raised by the pumps. We could not describe this arrangement briefly.

STEAM ENGINE COEFFICIENTS.

To the Editor of Engineering.

Sir,—I think it highly desirable that not a single incorrect statement should be allowed to pass unnoticed in your very valuable journal, especially upon a matter of so high importance as steam engine economy; and thanks are due to Mr. Gray for first calling the attention of your readers to the impossible coefficients of diagrams published in yours of September 15th, page 176.

The highest coefficient which I have obtained from very economical compound engines, is 2.65; the average pressure being 12.45, and the final pressure $4.7 \div \frac{12.45}{4.7} = 2.65$. The diagrams from which this coefficient was obtained, were far nearer to perfection than those illustrated on page 175, that is to say, the cut-off was sharper, the proportion between cylinders and the point of cut-off were better arranged, so as



to avoid the sudden fall at the end of diagram from high pressure cylinder; and, finally, the loss between the cylinders was much smaller.

The terminal pressure in large cylinder was in this case much in excess of what it should theoretically be, whereas in Mr. Smith's diagrams it is no less than might have been expected, and as the terminal pressure is not a true measure of the steam used, the coefficients obtained by using it as a divisor are not of the high value generally attached to them.

The best method of getting a good and general insight into the behaviour of steam in compound engines, is, I think, to put the diagrams of low and high-pressure cylinders together, as shown by the annexed figure. Care must, of course, be taken to use only such diagrams as are taken at or about the same time, or where the work done by the engine is irregular, the average of several should be taken.

As the capacities of passages, clearances, &c., are unknown to me, I have calculated them approximately from the compression corners.

The high-pressure diagram is the average of the two at upper left-hand side, page 175; and the low-pressure one is the average of the two immediately below, both being, of course, drawn to the same scale, viz., 20 lb. to the inch.

I should mention that this method of putting the diagrams together is far from being new, but is, I believe, very little used, although exceedingly useful.

$g f$ = volume of passage, clearance, &c., to small cylinder.
$a c$ = " " to large cylinder.
$f e$ = volume of small cylinder.
$g p$ = " of large cylinder.
70 lb. is absolute initial pressure in small cylinder.
17 lb. is absolute average pressure in receiver.
$r d$ is the correct expansion curve for steam in jacketted cylinders.
$g d$ represents final volume of steam in small cylinder passages, &c., at a pressure of 17 lb.
$g b$ of this volume is compressed into the passages, &c., and $b d$ only is sent into large cylinder.
$a b$ is portion of passage, &c., to large cylinder, which is occupied by the steam (of originally 1¼ lb. pressure) compressed by large piston.
$d o$ is correct expansion-curve for steam in jacketted cylinders.
k, l, m, n, o, p, q is the theoretical diagram, which should have been produced in a single cylinder of same capacity as large cylinder, clearance being *nil* and vacuum perfect.

Average pressure of the two I make 15.98, and final pressure 5.58 lb. $\frac{15.98}{5.58} = 2.86$, which is very high, for reasons already given.

Average pressure of the theoretical diagram is 20.96, and $\frac{15.98}{20.96} = .762$, a coefficient which shows the amount of work got out of steam, compared with what you ought to have obtained under perfect conditions.

The engine from which these diagrams were taken, appears to suffer from an insufficiency of jacketted surface for the steam in cylinders, or possibly an inefficiency of same. Or it may be from some fault equivalent to the barrel-shaped cylinders proposed by Mr. Gray.

W. Schonheyder.

London, October 23, 1871.

To the Editor of Engineering.

Sir,—I would not have troubled you with another letter on this subject, but for the ill-used tone of the last letter of "J. J. C." He accuses me of wilfully misrepresenting his statements, in order to avoid discussing the various questions he raises. Now, to be frank with "J. J. C.," I have neither time nor inclination to discuss such subjects in this way, and after establishing the direct accuracy of my own deductions, prefer to have done with the subject. For it seems that "J. J. C." did not write so much with a view to correct me, as to take the opportunity of introducing his own fractional form of coefficient, and which he endeavours to assure us is the only form in which coefficients have any value. But as an atonement to "J. J. C." for my alleged off-handedness, I will now briefly discuss the other points referred to in his letter.

In the first place, what I called his virtual statement was deduced from the sentence at the beginning of his letter, where, as an argument against measuring the steam at the terminal point, he says, "Wire-drawing the steam passing into the large cylinder will partly cause a fall of terminal pressure."

According to "J. J. C.," it is then because the steam is *wire-drawn* that the terminal pressure is not an exact measure of the quantity admitted. And we are, on the other hand, justified in assuming him to mean that if the same steam had been freely admitted, it would have had a higher terminal pressure, and could then have been measured to obtain the expansion; *ergo*, "expansion will not be the same in amount if the given quantity of steam to be expanded is wire-drawn instead of being freely admitted." And the explanation of "J. J. C." as to the cause of this phenomenon, *even* when amended by the substitution of radiation for reaction, certainly does not help his case; for he evidently forgets that it is not the steam, but the heat, that radiates from the receiver, leaving the equivalent of the steam in the form of water, all of which must pass through the low-pressure cylinder, and be again re-evaporated by the time it reaches the terminal point of expansion. Now, it may be that "J. J. C." finds something farther on in his letter that clearly shows he held no such opinion as above expressed, but he should remember—and I would ask Mr. Gray to note this also—that it is from what is said, and not from what is meant, that inferences in such cases can alone be drawn; and I don't think that "J. J. C.," after reconsidering this, will blame me for taking his words

at their legitimate value, even although he finds that he contradicts himself a little farther on.

Again, "J. J. C." thinks that the terminal pressure will not be so high in fast engines as it will be in slow engines, because there is less time for re-evaporation of any water formed in cylinder at commencement of stroke. Now, in the case of a jacketted cylinder it is generally understood that there is no water formed at commencement of stroke, and therefore it cannot be re-evaporated at end of stroke. And in the case of an unjacketted cylinder, if the piston travels so fast as to give less time for re-evaporation, it will also just give proportionately less time for condensation; and, moreover, were there no re-evaporation there would practically be no condensation, it being the re-evaporation *per se* that occasions nearly the whole of the condensation at the beginning of the stroke. So that in no case does this assumption of "J. J. C." hold good.

As to "J. J. C.'s" own particular form of coefficient, and which he says is the only one of any value, it must be said that it has the distinguishing feature of showing the worst possible engine to be as good as the best possible. Thus his coefficient of perfection is a constant of 1, and supposing a single cylinder engine supplied with steam the full length of the stroke—which is supposing the worst possible conservation of the steam—it would be quite competent for that engine to realise "J. J. C.'s" coefficient of perfection. This of itself shows how utterly valueless is such a coefficient of efficiency. Whereas the usual coefficient conveys to the mind an immediate and correct measure of the value of any engine as an economical steam user. And in all cases the higher the coefficient the greater the economy of steam, be the distribution of the steam what it may. I trust in discussing the remaining parts of "J. J. C.'s" letter I have afforded him the required satisfaction, and that he will now believe that in previously avoiding this discussion I neither did adopt nor had any occasion to adopt, an ingenious device to do so.

Yours respectfully,

CHARLES SMITH.

Hartlepool Iron Works, Oct. 25, 1871.

THE PALLISER-PARSONS BOLT.

TO THE EDITOR OF ENGINEERING.

SIR,—I notice a letter headed as above in your paper of last week from Mr. F. A. Paget, in which he notes that he provisionally protected and abandoned a form of bolt with a hollow shank on September 11th, 1866, which was anterior to the date of my patent.

I do not quite see the drift of Mr. Paget's communication, but if it is to show that he thereby established a prior moral claim to the invention, notwithstanding the legal right my patent gives me to it, I beg to refer him to the provisional protection I obtained August 6th, 1866, in which the tubular shanked bolt is specified and which is anterior to his application of September 11th.

My patent of February 5th was substituted for this provisional protection, as there were some details which it was considered desirable to amend and which could but be done by commencing a new patent; but my first application is sufficient to show that I had invented and specified the plan before Mr. Paget made any application for provisional protection. Moreover in my patent the principle of the invention is carried out more completely than Mr. Paget contemplated, his idea being confined to making the shank tubular while mine embraces in addition to this form various others, for reducing the shank externally so as to make it of equal strength with the screwed portion, and still keeping parts of its perimeter of the full diameter so as so fit the hole the screwed part would have to pass through. As regards working the invention, not only have I submitted it to both the War Office and the Admiralty, but I arranged with Mr. Hughes at a considerable expense to substitute these bolts for ordinary ones in the Millwall shield, and it is admitted that the extraordinary resistance exhibited by that structure to the firing of the heaviest guns in the service, was as much due to the perfect manner in which the bolts fulfilled their office and held the parts together as the admirable system upon which those parts were constructed. I had, moreover, made a series of careful experiments with and introduced the bolts with the shanks reduced externally for securing fishing plates on many of the leading railways, and it was only in consequence of the fear of litigation (now happily averted) that large contracts which had been made were not proceeded with.

Therefore without in the least desiring to detract from any merit that may be due to Mr. Paget in the matter, I trust the above remarks will show that I have morally a better claim to the invention than he, independently of the legal right my patent confers on me.

I am, Sir, your obedient Servant,

P. M. PARSONS.

Blackheath, October 25, 1871.

SOUTH WALES INSTITUTE OF ENGINEERS.

THE ordinary general meeting of the members of this Institute was held in the theatre of the Royal Institution of South Wales, at Swansea, on Saturday, the 14th of October, Mr. William Thomas Lewis, member Inst. C.E., President, in the chair.

The nomination of office bearers for the ensuing session took place. The following gentlemen were balloted for, and elected as members of the Institute, viz.: Mr. Thomas Price, Bryuna Colliery, Bridgend; Mr. Lawrence Heyworth, Waun Fawr House, Newport; Mr. William G. M'Murtrie, Camerton Colliery, Bath; Mr. Walter Bell, Merthyr Vale Colliery, Mr. George James, Risca.

The president formally admitted the following members elected at the previous meeting. Mr. Charles Henry James, Merthyr Tydvil; Mr. Matthew John, junior, Merthyr Tydvil; Mr. Charles John Sharpley, C.E., Allyheer, India; Mr. Walter Lewis, Swansea; Mr. James Burrow, Maesteg; Mr. David Joseph, junior, Trekerbert.

A discussion took place on a paper by Messrs. W. Thomas Lewis and Morgan Reynolds, on "The South Mineral District," which had been read at a previous meeting. Carefully executed plans and sections, drawn on a large scale, to illustrate this paper, were exhibited on the walls. The discussion, however, was one possessing but local interest, and would scarcely be intelligible if reprinted apart from the paper and diagrams to which it belonged. At its conclusion, Mr. Glasbrook said that he thought it might be desirable if the different colliery proprietors would furnish sections of their pits; and he should have much pleasure in placing the data that he has at command before the Institute in the form of a supplementary paper.

The President concurred that this was a very proper subject for a committee, but as its consideration would involve very considerable labour on those gentlemen who accepted the responsibility, he thought it would be much wiser to postpone the appointment until the other papers on this subject had been brought before the Institute, so that the whole district might be dealt with simultaneously, with the hope that it would lead to a complete identification of the various coal seams and an uniform nomenclature.

The next paper brought up for discussion was by Mr. Thomas Joseph, "On the Changing Character of Coal from Bituminous to Anthracite," which had been read at a previous meeting.

The President was sure he only expressed the opinion of the members in saying that the subject was a most interesting one, and that after the care and ability displayed by the author, they should only be doing their duty in discussing the subject thoroughly, and, if necessary, adjourning it from time to time for that purpose.

Mr. Bedlington concurred with the author in attributing the "slip cleavage" to the action of magnetic currents over lengthened periods of time; but he could not agree with him as to the formation of all the "slips" alike, nor that there are no slips in the highly bituminous seams of coal. He did not clearly understand the writer's views as to the relation he attributed between the presence or absence of slip cleavage and the presence or absence of free gas in the coals, whether he considered the slip cleavage acted simply as a drain or channel whereby the gas was more readily liberated from the coal, and thus present in larger volumes with slip cleavage, or did he think its absence, where the slip cleavage is almost wanting, was due to a peculiar composition of the coal?

Mr. Thomas Joseph thought all our veins of coal were originally bituminous, and in that state the gas existed as bitumen in the coal. On the production of the slip cleavage, the bitumen was to some extent decomposed by the same magnetic action that produced the slip cleavage, and that the free gas thus evolved remained in the slips and cracks of the coal and adjacent strata, producing the gas or fire-damp found so largely in the Merthyr steam coal districts. And that this action was gradual and progressive, from the normal bituminous coal to the pure anthracite. He thought the alteration in quality of the coals was due to magnetism or electricity only.

Mr. Bedlington considered that the author should produce some evidence to bear out the hypothesis which he had advanced, for to his mind it was difficult to ascribe the slip cleavages, and the changing character of the coal, with any degree of satisfaction, or certainly to the effects of magnetic, or electrical forces only.

Mr. Thomas Joseph said that one strong reason that we should expect these great changes to be caused by electricity was the thoroughness of its working. It is well known also that electricity will vaporise any fluid compound, and we find free gas in these coals of a semi-bituminous and anthracite character, where we may assume the coal was nominally of a highly bituminous quality. The changing action takes effect from the lower seams upwards, due, as I believe, to intense electrical action, which at times becomes evident to our senses, in the noises accompanying earthquakes, and which are supposed by many eminent men to be but discharges of electricity. The slips in the coal and in the accompanying strata are found to lie in the direction of the lines of the magnetic force, that is between the two poles.

Mr. W. J. Gabe did not agree with the author as to the agency which produced the change in the character of the coals. He had some doubt whether all the seams of coal in this basin were originally bituminous. There can be little doubt but that coal was the result of vegetable decomposition, aided by heat and the pressure of the superincumbent strata; and it appeared to him that the coal as it is now found is nearly of the same character to what it was in its original condition after solidification. He was inclined to think that the heat required for the decomposition and conversion of the vegetable matter into coal was derived from the centre of the earth, and that during this process of coal-making it produced a greater effect upon the western end of the coal basin than on the eastern, so that the coal varied in quality from anthracite to highly bituminous. The cause of this unequal action is, he believed, to be attributed in a great degree to the thinning out of the old red sandstone from the east, where it is some 8000 ft. in thickness, to the west, where it almost thins out altogether; and that the heat did not penetrate to the eastern portions of the coalfield with sufficient strength to drive off the bitumen from the coal, because it had to pass the 8000 ft. of old red sandstone, but that on the western part of the basin this protecting barrier of old red sandstone having thinned out, the heat was sufficiently powerful to drive off all the bitumen in the coal, producing the pure anthracite. A practical knowledge of the coking qualities of the various coals in different localities confirms this view of the matter very strongly, and it is found that the coals are more bituminous to the eastwards, and also that the upper coals are invariably more bituminous than the lower ones in all the different districts in the coalfield. He thought that the slips were caused by the action of magnetic forces, but we find slips in every direction, and unquestionably the magnetic force was much stronger in some geological periods than in others. The Cambrian and Silurian formations have many more cleavages than in those overlying, and possibly this may have arisen from the greater temperature under which these rocks were formed, inducing a more powerful magnetic action.

Mr. M'Murtrie did not think the arguments urged by Mr. Gabe would hold good throughout all the coalfields. In the North of England some of the upper seams are the best steam coal, whilst the lower seams are the best gas and coking coals. In Somersetshire also some of the deepest are the most bituminous. In respect to the author's theory of the action of electricity upon the slip cleavage, he thought it was a question whether the veins of coal lose their bitumen in proportion to the presence of slip cleavages.

Mr. Thomas Joseph considered that Mr. Gabe's remarks tended rather to support his view than otherwise; it was a question, he thought, whether the internal heat was not the result of electricity.

The President was sorry to say that he had not been able to give this subject the attention it deserved, but in his opinion the line of "dark smoky" coals lies further south than it is shown on Mr. Joseph's plan in the Rhondda Fawr and Rhondda Fach Valleys.

Mr. Thomas Joseph said that at Dinas, the coal was "dark smoky," he followed the beds according to their stratification.

The President remarked there was no evidence as to the coals increasing in bitumen at Ferndale, towards Porth. He thought Mr. Joseph was arguing upon what is found in the upper coals. The steam coal is not "dark smoky" at Ferndale.

Mr. Hugh Begg said he had taken coals from Llwynpia and from the Park collieries, and had coked them purposely to judge if one was more smoky than the other, but he could observe no difference.

The President said if we take the Navigation coal, there was no evidence that it increased in bitumen and became more smoky to the south; and he thought that was strong evidence against the line of "dark smoky" adopted by Mr. Joseph.

Mr. Thomas Joseph remarked that the coal was very bituminous at Dinas.

The President thought that was no proof of its increasing in bitumen at Navigation, or in the western portion of the Rhondda Valleys.

Mr. Thomas Forster Brown, in moving the adjournment of the discussion to the next meeting, said he thought the slip cleavage might be due to both electricity and heat. He thought the loss of bitumen from the coal over a portion of the coal field was due to the action of internal heat, a strong proof being that the further away from the lower beds and rocks, the more bituminous the coal becomes.

Mr. R. Bedlington, in seconding the motion for adjourning the discussion, remarked that there are many different elements in the composition of coal. It is known that it is derived from vegetable matter; these vegetable matters may vary much in their composition, and he did not see why coal in like manner should not vary in composition from the same cause. There may, however, be changes of character caused by electricity and from heat.

(*To be continued.*)

THE GREAT WESTERN RAILWAY.—On the 30th inst. a new station, to be called Royal Oak, between Westbourne Park and Bishop's-road, will be opened for traffic; and on the same day a new station will be opened at Westbourne Park, at which nearly the whole of the Great Western main line trains will call.

ENGINEERING SOCIETY; KING'S COLLEGE.—A meeting of this Society took place on the 20th of this month, 18 members were present. A paper on Mont Cenis was read by the President (Mr. Hunter), who very clearly described the methods pursued in constructing the tunnel and the machinery. The paper was illustrated by the drawings of Mr. Vivian.

A WONDERFUL GUN CHARGE.—The military and naval correspondent of the *Times* recently entertained the readers of that journal with a startling piece of intelligence respecting an extraordinary gun charge. Referring to a series of experiments, which are being carried out at the present time by the Committee on Explosives with the 10 in. gun at Woolwich, we find the following statement: "The gun was fired with the enormous charge of 700 lb. of powder, and a cylinder weighing 800 lb., the consequences being rather more than were anticipated, as the gun was dismounted from its platform, and the patent buffers considerably damaged." Inasmuch as such a charge would be "rather more" than the bore of the gun would contain, it is not unreasonable to suppose that the results were "rather more" than were anticipated. The Committee are experimenting with the view of ascertaining the pressures at intervals throughout the whole length of the bore of this gun, and also of testing its endurance. But we think it is carrying matters a little too far when we find it stated by the same writer that "the gun has, however, to undergo still further trials, for it has to be fired with four charges of 1000 lb. of powder each, and four of 1200 lb. each." However, the Committee know their own business best, and we suppose they will find a way of stowing away powder and projectile somewhere or other in the gun, or if they cannot, the *Times'* writer will doubtless find it for them. Truly, we should live in wondrous times did not the facts of the case slightly differ from what the *Times'* correspondent would have us believe. As it is, the 10 in. gun has only been fired with powder charges of 70 lb. and 87 lb.—and these were rather high we should say—and with projectiles weighing 400 lb. and 800 lb. It is true that the gun has to undergo further trials, possibly with heavier charges, but what those charges are to be has not yet been decided. The imaginative genius on the *Times*, however, may take our word for it that the Committee do not at present contemplate using 1200 lb. powder charges—nor even 700 lb.—with the 10 in. gun.

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ENGINEERING.

FRIDAY, OCTOBER 27, 1871.

THE MEGÆRA.

THE story of the Megæra has now been completely told, and the blindest and most unscrupulous defenders of an incompetent Administration will have hard work to explain away even to their own satisfaction the criminal stupidity that so nearly caused the loss of all on board the worn-out vessel. For many months the Admiralty, through its mouthpieces, had the power of denying the serious charges brought against them, and if the Megæra had reached her destination in safety, or had she gone down with all her crew, Mr. Goschen and his responsible colleagues would have saved their reputation, and the country would have continued to believe that the charges of incompetence brought against them had no better foundation than mere personal animosity. Fortune, however, did not smile upon the First Lord, and, thanks to the ability and unceasing energy of her captain, the Megæra safely reached the island where she now lies. Let us briefly glance at the circumstances which occurred after she left Queenstown, subsequent to her inspection (!) at that place by the Admiral. Almost by a miracle the Megæra achieved a part of her voyage in safety, and apparently without making much water, but on the 8th of June it was found that she leaked considerably, and so ignorant were those on board of the condition of her plates that they attributed the leak to the loss of a rivet in her bottom. It was soon found, however, that the water gained, and nothing was left but to make for St. Paul's, where the captain hoped he might be able to make such temporary repairs as should enable the vessel to arrive at her destination. But when St. Paul's was reached in heavy weather, and an examination was made by means of the diving apparatus, which had been demanded by the captain before he left England, the real cause of the leak was quickly apparent. The plates were worn away, holes were found, and the iron was scarcely thicker than a sheet of paper. The officers who were enabled to make an examination reported "that, even in the event of the present leak being thoroughly stopped, the plate is so honeycombed from corrosion, which they attribute to age and wear, that they consider it most unsafe to proceed on the present voyage unless a thorough examination of the ship's bottom could take place, removing the cement, and putting new plates on, which under the present circumstances is utterly impossible." And again, Captain Thrupp states that

"The diver reported the ship's bottom was generally clean, but there were several rusty spots; the leak he discovered by placing his hand over each until he felt the suction of the leak through the hole, he could not say whether the other rusty spots were nearly leaks or not, but the corners of two overlapping plates were eaten away near the bad plate to the extent of 4 in. by 1½ in. He could easily have picked through the rusty iron left with his knife, but thought it would not be right to do so. Besides these rusty spots, damaged corner-plates, and the leak itself, the diver reported five or six plates, from the keel upwards, looked very rusty under the stokehole. Between eight and nine a.m. on that Sunday, the 18th of June, Messrs. Mills and Brown reported again to me that, upon a further examination when the ship was pumped out dryer, we found many of the girders eaten through at the bottom, and others nearly so, one of those quite through ran across the plate through which the leak had taken place.

"The bilge pumps were constantly being choked, and on the doors of the valve boxes being taken off to clean them, also the lid of the non-return valve, pieces of iron were taken out about a quarter of an inch thick and an inch and a half diameter, evidently having been washed from the bottom, for some of them had remains of cement on them."

The foregoing extracts explain the whole cause of the disaster, and relate it so plainly that no one can fail to appreciate the enormity committed by the Admiralty in sending the ship to sea. That body cannot even take shelter behind the flimsy protection afforded too often by the excuse that there were no data upon which to estimate the danger. Nearly 30 years old, the Megæra had long been reckoned as unseaworthy, and Mr. Goschen and his colleagues must have been aware of this fact before she started on her final voyage. And although the First Lord may naturally plead that he was new to the position he holds, and was entirely ignorant of his duties, it might have been expected that practical advice on the subject was attainable. But there is a circumstance worthy of especial notice in this matter. When the question of the safety of the Megæra was discussed in Parliament last winter, it will be remembered that the gentlemen who expressed their grave doubts, were met with unseemly flat contradiction. Were those high spoken denials simply the expression of gross ignorance, or were they deliberate untruths? Bearing in mind that the general condition of the Megæra was officially recorded, and that an inspection had been made—so it was said—at Queenstown, we can scarcely arrive at any other than the latter conclusion, and that the strongest attempts were made to cover the first fault at any price, the delinquents at the Admiralty trusting to good luck to keep the ship afloat till she reached Australia, when she could have been quietly disposed of, and official credit saved. If any inspection was really made at Queenstown, the condition of the vessel would have been ascertained more easily than it afterwards was at St. Paul's, and no terms of condemnation can be too strong for an act that dismissed a large body of men on so desperate a service. On the other hand, if the inspection was not made, false statements were very freely uttered, and anyhow a gross attempt has been made to deceive the public and to maintain official credit even at the cost of hundreds of lives. Either the ship was examined at Queenstown, or she was not; if she was inspected, it was well known at the Admiralty that her plates were rusted down to the thinness of paper, and that her beams were eaten through; if she was not inspected, the position in which the Admiralty stands towards the country could not possibly be worse; a third suggestion, namely, that an inspection was ordered, and imperfectly made, is not very probable, for the subordinate servants of the departments know and do their duty better than their superiors.

In whatever light it may be regarded, the loss of the Megæra admits of no palliation whatever, and the public will, with unanimous voice, demand that the authors of the crime be brought to justice. The *Pall Mall Gazette* considered that some one ought to be hanged. We do not go so far as our contemporary, though possibly such a course might serve as a warning, and could be executed without much loss to the State. But we protest, in the name of the whole nation, against the appointment of men to responsible situations for which they are utterly unsuited, and against the facilities they possess for stepping out of unpleasant positions into which their ignorance or folly has brought them. If justice be done in this matter of the Megæra, we shall have some confidence in the possibility of Admiralty reform, but if, as has happened before, the public welfare is made subservient to personal interest, our navy must remain at the mercy of the administration that now misdirects it until better times.

STEAM ON THE FARM.

THE current number of the *Journal of the Royal Agricultural Society of England** should be in the hands of all interested in the progress of steam cultivation, and in the use of steam power for farm purposes generally. In July last the Royal Agricultural Society—as most of our readers are no doubt aware—carried out at Wolverhampton a most extended series of trials of steam-ploughing machinery and of traction engines intended for farm purposes, and it is the results of these series of trials, which are given in the number of the *Journal* to which we have just referred. The data collected at Wolverhampton are given in the *Journal* in a brief "Report on the Trial of Implements at Wolverhampton and Stafford," by Lieut.-Col. F. M. Wilson, senior steward; in a "Report on the Trials of the Steam Cultivating Machinery at Wolverhampton," by John Algernon Clarke; in a "Report of the Judges on the Trials of Traction Engines at Wolverhampton," by F. J. Bramwell, C.E., and James Easton, C.E.; and lastly, but by no means least, in a set of admirably detailed Tables, which accompany these reports, and which were prepared by the consulting engineers to the Society, Messrs. Eastons and Anderson, and their assistants. The great length of these reports, and the fact that they necessarily contain much information which has already appeared in our pages, of course prevent us from reprinting them in this journal, while to publish them in abstract, would, we consider, be manifestly unfair to their authors, as giving no just idea of the labour which has been bestowed upon their work. But while this is the case there are several prominent facts brought to light by the Wolverhampton trials, which deserve a far wider publicity amongst engineers than it is probable that they will get through the channels of the Society's transactions, and respecting these facts, therefore, we propose to say something in the present article.

One of the most striking features which distinguished the Wolverhampton experiments from those previously carried out by the society, consisted in the application of the indicator to the farm locomotives during the trials on the brake and to the steam-ploughing engines while at work in the field. It is true that from defects in the fittings and indicator gear supplied by some of the exhibitors, and from some other causes which it is unnecessary to enter into here, the indicator experiments were not so complete as was desirable; but, despite their imperfections, they furnished much valuable information, while, moreover, they tended to familiarise agricultural engineers with the use of an instrument which should be employed habitually by every engine builder. It will be remembered that, while the Wolverhampton trials were in progress, we devoted much space to an account of them, and it was our endeavour to make this account as complete as was possible in the time available for its preparation. The revelations of the indicators were, however, accessible to but a very limited extent at the time that our reports were published, and hence it was impossible to deduce from the experiments the facts of which we propose now to speak.

The first of these facts—and a very curious and valuable fact it is—is that the power expended in moving earth by steam-cultivating tackle is prac-

* *The Journal of the Royal Agricultural Society of England*, Second Series, vol. vii., Part II. London: John Murray.

tically unaffected by the speed at which the earth is moved. In their very complete table showing the results of the trials of steam-cultivating machinery, Messrs. Eastons and Anderson give columns containing respectively the weight of earth moved per yard run of implement, and the number of foot-pounds of work indicated by the engine per yard run of implement; and from these is deduced the indicated work of the engine in foot-pounds per pound of earth moved, this being given in another column. The following extracts from this column are given as proving the fact to which we have referred:—

			Indicated work of engine in foot-pounds per lb. of earth moved.
Amies	and	Barford—full speed ...	12.6
,,	,,	half speed ...	13.8
Barrows	and	Stewart—full speed ...	11.4
,,	,,	half speed ...	13.3
,,	,,	full speed ...	10.0
,,	,,	half speed ...	8.8
Ravensthorpe Company—		full speed ...	21.0
,,	,,	half speed ...	22.0
,,	,,	one-third speed	19.5

These results show that, practically, the resistance was independent of the speed, and they tend to prove, moreover, that almost the entire power is absorbed in simply breaking the earth and overcoming frictional resistances—that power expended in throwing the earth upwards or to one side forming no appreciable portion of the whole. The power absorbed in the latter way will of course increase as the square of the speed, and had it been great in amount, the effect of the speed would have been visible in the results we have quoted.

It unfortunately happened that from the shortness of the trial at Barnhurst, and the bad weather and bad water which had to be contended against at Stafford, the indicator experiments on Messrs. Fowler's sets of double-engine tackle were very far from complete, and reliable information, therefore, is not available as to the power expended in doing the work on that system. The average results obtained on the heavy lands at Stafford, however, in which diggers were used, were as follows: Fowler's various systems of tackle showed an expenditure of 21.8 foot-pounds of work per pound of earth moved, while in the case of Messrs. Howard's various systems the average was also 21.8 foot-pounds, and with the Fisken fast-rope tackle 22.9 foot-pounds. It appears also from the experiments that the ploughs and diggers required about 10 per cent. more power than the cultivators per pound of earth moved, the ploughs, however, being rather more easily worked than the diggers. The average results obtained in the light and heavy loads at Barnhurst and Stafford, respectively, were as follows:

	Foot-pounds of work per pound of earth moved.	
	Light land.	Heavy land.
Dug or ploughed	17.7	21.7
Cultivated	15.2	20.3

The heavy land thus caused an increase of the resistances amounting to about 28 per cent. The following deductions as to the expenditure of stores per acre, and the performance of the ploughing engines, although to some extent imperfect, on account of its having been impossible to make complete observations on all the sets of tackle, are also of much interest.

	Maximum.	Minimum.	Average.
Consumption of coal per acre ...	208 lb.	119 lb.	161 lb.
,, ,, water ,, ...	...	...	115 gals.
,, ,, oil and tallow per acre	...	...	5.1 oz.
Water evaporated per pound of coal	9.15 ,,	6.5 ,,	7.9 lb.
Coal burnt per mean indicated horse power per hour	6.0 ,,	5.3 ,,	7.1 ,,
Weight of earth moved per pound of coal	11.5 tons	7.43 tons	9.3 tons

In the report on the experiments with traction engines the principal facts not already given in our own accounts relate to the information afforded by the use of the indicator during the brake trials. It appears from these results that the loss by friction, or the difference between the power given out on the brake and the indicated power, averaged, in the case of these engines, 16 per cent. of the indicated power, the maximum loss being 24 per cent., and the minimum 12 per cent. In the case of Messrs. Aveling's three engines the average loss was but 13.7 per cent., the maximum loss being but 16 per cent., or the same as the average for the whole of the engines tried. The coal burnt per indicated horse power per hour varied from 3.2 lb. as a minimum (in the case of Messrs. Aveling's 10-horse engine) to 5.1 lb. as a maximum, the average being 4 lb. for engines with locomotive boilers, 4.4 lb. for those with pot boilers, and 4.22 lb. for the whole number of engines tried. Perhaps, however, the most unexpected fact shown by the report is that, whereas the five engines with locomotive boilers and steam-jacketted cylinders used on an average 32.7 lb. of steam per indicated horse power per hour, the two engines with pot boilers and unjacketted cylinders used but 27.8 lb. only. It appears probable that this result was due to some priming taking place with the former, and a certain amount of superheating with the latter boilers; but this is a point on which, as well as some other matters set forth by the report, we shall speak on some future occasion. At present we merely record the fact; but in doing so we should at the same time mention that, notwithstanding the differences in the averages, the minimum consumption of steam per indicated horse power per hour was practically the same for the two classes of boilers, being 27.3 lb. for the locomotive and 27.4 lb. for the pot type.

THE 35-TON GUN.

The 35-ton 700-pounder gun has recently entered upon a new phase of its chequered existence, having been bored out to a calibre of 12 in., which it was originally intended it should have. It will be remembered that at its proof, when its calibre was only 11.6 in., it gave very singular and uncertain results as regards pressures and velocities. It did not consume the whole of its powder charge, and the remedy for this defect has been the enlargement of the bore. By this means it was anticipated that the whole of the charge being shortened would be consumed, and that better results altogether would be obtained. We much question whether the remedy is not worse than the disease as far as the ultimate efficiency of the weapon is concerned, and for obvious reasons to which we shall return. The gun was tried at Woolwich last week under its altered structural conditions with 110 lb. and 115 lb. powder charges and a flat-headed solid 700 lb. projectile. Two different kinds of pebble powder were used, viz., Waltham Abbey large grain, and Belgian small grain. The results of the practice are given in the following Tables:

First Series of Experiments.

No. of round.	Powder charge.	Description of powder.	Weight of projectile.	Initial velocity in feet per second.
1	110	Waltham Abbey large grain ...	700	1274
2	,,	Belgian small grain	,,	1301
3	,,	Waltham L. G.	,,	1269
4	,,	Belgian S. G.	,,	1302
5	,,	Waltham L. G.	,,	1272
6	,,	Belgian S. G.	,,	1300

Second Series of Experiments.

1	115	Waltham L. G.	700	1300
2	,,	Belgian S. G.	,,	1340
3	,,	Waltham L. G.	,,	1289
4	,,	Belgian S. G.	,,	1355
5	,,	Waltham L. G.	,,	1295
6	,,	Belgian S. G.	,,	1360

Judging from the above Tables the results at first sight would appear to be in favour of the Belgian powder. As far as velocities are concerned this is so to a slight extent, but the pressures with the Belgian powder were much higher than those given by the Waltham powder, even proportionately to the velocities. This disadvantage, therefore, more than counterbalances the slight increase in velocity. In the second series of experiments the pressures were found to be considerably less than in the first series. The highest pressure registered with the Belgian powder was 30 tons on the square inch, whilst that exerted by the Waltham Abbey powder was somewhat under 25 tons. This contrasts favourably with the 47 tons per square inch obtained from the experiments made in the early part of the year. In all the experiments above recorded it is presumed that the whole of the powder charge was ignited, inasmuch as no unconsumed grains have since been found between the gun and the target. So far, then, the results have proved highly satisfactory to the Committee on Explosives, who are congratulating themselves upon having got the gun to do all that was expected from it; that is, as far as regards the nature of the tests hitherto adopted. But we would remind them that in the trials made with the great gun, whilst its calibre was 11.6 in. some still better results were obtained than those above recorded. We refer particularly to one round—No. 20 of the early series if we rightly remember—which was fired with 120 lb. of pebble powder, unglazed and of uniform grain. There a velocity of 1353 ft. per second was obtained, with a pressure at the vent of 20 tons, and on the base of the projectile of 21.7 tons per square inch. Having hit upon these results we think experiments should have been pushed further with the same powder before re-boring the gun.

But the real efficiency of the gun is not so much to be measured by the results of pressure and velocity, as by those of accuracy and penetrative power for which it yet has to be tested. And this brings us to our reasons for questioning whether the remedy of boring it out to a larger calibre is not worse than the disease. The altered conditions of course necessitate an altered form of projectile. To preserve the same weight with an increased diameter it must be made shorter, and this altered form is open to three serious objections. In the first place the shortening will give rise to unsteadiness in flight, whilst in the next the enlarged diameter will offer a greater resistance to atmospheric pressure. The result of this will be, in the third place, that the velocity will fall off as the range increases, and the penetrative power will be reduced in a corresponding degree. Moreover, the projectile having an increased diameter, will have of itself more work to do in penetrating the target when it reaches it, as it will have to make a larger hole, and this, too, under the impaired conditions to which we have just alluded. The fact is that the proportions of the gun have been bad from the first. Had Colonel Campbell been asked to build a gun to carry a given weight of metal, say, 700 lb., he would doubtless have produced the present weapon, but with an increase of about three calibres in its length. It would then have consumed the whole of its powder charge, and for aught we can see, would have given no trouble to the Committee on Explosives. As it is, the Admiralty fixed the main details of the gun, the dimensions being governed by the size of the turret, which is much too short in proportion to the weight of the projectile. They have, in fact, built their carriage first—for a turret ship is but a gun carriage—and ordered the gun to suit the carriage instead of doing the reverse, as common sense alone ought to have suggested should be done. However, as the gun has satisfied the Committee at Woolwich we can only hope it will not disappoint them at Shoeburyness; it is to be remembered that there are nine more of these monsters whose fate we are anxiously awaiting.

A NEW GAS.

Judging from the frequent attempts that are made either wholly to supersede ordinary coal gas, or to improve its manufacture, there must be a very widespread dissatisfaction with our present means of illumination. And this feeling appears to increase just in proportion as the manufacture and use of gas extends. But in truth, at the best, the ordinary product of our gas companies is certainly open to improvement. What we want, and what we ought to have in this much vaunted age of scientific progress, is a gas possessing greater purity and higher illuminating power, and which will prove more economical to the consumer than that with which we are at present supplied. To attain this end many variations have been introduced at different points in the process of manufacture, and many schemes have been devised for treating the gas at the burner. All of these notions have resulted in a greater or lesser degree of success, more generally lesser than greater. Carburation has at all times had its votaries, and the attempt to convert the volatile constituents of the residual products into permanent gas, has been made over and over again, but, up to the present time, without success. It has been the *bête noir* of many inventors in this direction, who have always been foiled by the production of other liquid hydrocarbons, which have either condensed when the gas cooled, or, at the best, before it had travelled any great distance. The failures of some do not appear to have prevented others from following up this seductive subject, but rather to have stimulated them to further researches. This was the case with Dr. Eveleigh, who, so far as we are at present able to judge, has succeeded in converting the residual products into permanent gas, in a thoroughly practical manner.

Fully impressed with the feasibility of the idea,

Dr. Eveleigh some time since erected a small gas-works in the rear of his house at Peckham. There he experimented, altering and varying his apparatus from time to time as he found necessary, until at length he was enabled by it to effect the object he had in view. The apparatus consists of a bench of iron retorts, in which the best and richest portions of the gas contained in ordinary Newcastle coal are distilled over at the comparatively low temperature of about 900 deg. Fahr. The hydrocarbon oils go over with the gas, and they are carried together to a condenser, where the oily matters are rapidly condensed, the gas passing on to its own condenser and purifier. The hydrocarbon oils are collected and passed first into a heated pan, where they are re-vaporised, the vapours being conducted to a redistillation retort charged with charcoal, and heated to a temperature of about 1200 deg. Fahr. By passing these vapours through charcoal, it is found that they are decomposed and converted into a permanent gas, which, however, is of a lower illuminating power than that produced directly from the coal. This secondary gas is passed through a condenser, from whence it is conducted to a receiver containing the primary gas with which it is mixed, the union of the two giving a gas of very high illuminating power.

Dr. Eveleigh's experience during a long course of trials at his works is, that the retorts, the heating pans, and the re-distillation cylinders require only two-thirds of the quantity of fuel employed in the ordinary process, owing to the superior quality of the coke produced. As regards the results of working, he finds that one ton of Pelaw Main (Newcastle) coal, without the aid of cannel, produces 11,000 cubic feet of 18-candle gas with only 2 grains of sulphur in any form in 100 cubic feet, or about one-twentieth of that usually found. By slightly increasing the distilling heat, 12,000 cubic feet of 17-candle gas can be obtained from the same quantity and description of coal as above, but with a slight increase of sulphur, not however exceeding 5 grains. The yield of oil is found to be twenty gallons per ton of coal, and in its re-distillation two valuable products are obtained in addition to the gas. One is the pitch, which has been assessed at a very high market price; and the other is a drying oil, which Dr. Eveleigh states to be of value for varnish or painting external work, especially for ironwork, either exposed to the atmosphere or submerged in water. There appears to be no difference in the quantity of ammonia obtained, but it is stated to be produced in a better, purer, and more marketable form.

Any statements respecting the results of a new process which has been worked out to a successful issue, are very properly liable to be received with caution—and even with distrust—when they proceed from the pen of the inventor himself. Dr. Eveleigh has, therefore, acted judiciously in inviting Dr. Letheby to inspect his works, and report upon his process of gas making, and the results produced. This Dr. Letheby has done, and a copy of his report now lies before us. He tested the illuminating power, and the chemical quality of the gas, which had been made and stored for several days at the works. The gas, having been produced at a low temperature, had a much less offensive smell than ordinary coal gas, and it was so rich in hydrocarbons that it could not be burned from a standard argand burner, with 15 holes, and a 7 in. chimney, at a greater rate than 4 cubic feet per hour. At that rate it gave the light of 15.74 standard sperm candles, each consuming 120 grains of sperm per hour. The illuminating power of the gas at the parliamentary rate of 5 cubic feet per hour, was therefore equal to that of 19.68 standard sperm candles. The illuminating power of ordinary London gas is from 14 to 17 candles, and even this result is only obtained by using a large proportion of cannel coal. With regard to the purity of the gas, Dr. Letheby reports that he found it quite free from ammonia and sulphuretted hydrogen. The quantity of sulphur in other forms was remarkably small, amounting only to 3.77 grains per 100 cubic feet of gas, or about one-tenth of what is frequently found in ordinary London gas. The illuminating power of the gas obtained from the volatile constituents of the tar was equal to 17.3 sperm candles. Dr. Letheby considers the results to be highly satisfactory, and to show that the process is capable of producing a rich gas of great illuminating power, and of remarkable purity as regards the absence of sulphur.

The question of the supply of a cheap, brilliant, and pure gas to the public is now occupying the attention of the Special Gas Committee of the Corporation of London. About twenty of the gentlemen composing this committee visited Dr. Eveleigh's works last week, and were satisfied with what they saw as bearing upon the question under their consideration. But however valuable may be Dr. Letheby's report, or the favourable opinion of a score of gentlemen composing a gas committee, neither one nor the other are, in the present instance, based on anything more than an experiment—a large one it may be, but an experiment still. It is, therefore, satisfactory, in the interests of what appears to be a very important discovery, to find that arrangement have been made with the directors of the Barnet Gas Works, whereby the merits of the invention will be put to the test of practical use under the ordinary circumstances and contingencies attending the supply of gas to the public. With this view the necessary alterations are now being made in the works for carrying out the arrangement, which provides for 100,000 cubic feet per day. The chief features of the agreement are, that the new gas company shall make and supply gas of 20 candles illuminating power, which shall be absolutely freed from ammonia, and in which the sulphur in any form shall not exceed 6 grains per 100 cubic feet. It is expected that the works will be completed in another month, when the merits of the invention will be more clearly and effectually demonstrated than in any other way. As soon as the works are in operation, we purpose availing ourselves of the permission of the directors of the new gas company to examine into the whole process and its results, and we shall place the particulars before our readers. Dr. Eveleigh's invention is of sufficient promise to justify the expectation that Barnet will prove the starting point from which we may hereafter date the supply to the public of brighter, purer, and cheaper gas than they can obtain at the present time.

THE SEWAGE AT BIRMINGHAM.

"How shall we dispose of our sewage?" This is a question which sorely exercises the minds of most of our town councils. At the present time the Corporation of Birmingham are upon the horns of a dilemma. By injunctions from the Court of Chancery they are obliged to adopt some efficient means of abating the nuisance which at present is caused by the sewage of the borough being discharged into neighbouring watercourses in an offensive form. By reason of the immense volume of sewage to be dealt with, and the peculiar physical position of the town, the problem to be solved stands alone; therefore but little guidance can be obtained from the examples of other towns.

This much is certain. Upon the action about to be taken by the Birmingham Town Council will very greatly depend the future of the sewage question throughout the whole country. For this reason the Report of the Sewage Inquiry Committee of Birmingham, which has just been presented to the Council, possesses a national interest, not only from the intrinsic importance of the subject discussed, but equally because of the exhaustiveness of the document itself.

Such being the case, we propose to examine the report, a copy of which lies before us. First, however, a word as to the circumstances which led to the appointment of the Sewage Inquiry Committee and the preparation of this report.

The town of Birmingham stands almost upon the ridge of high land which divides the eastern from the western watershed of England, and it is, therefore, remote, not only from the sea, but also from any large river. Such being its position, there are peculiar difficulties in disposing of the sewage of its large population. Hitherto almost the whole of the sewage has been drained into the small river Tame, polluting its waters to such an extent, that the Right Honourable Sir C. B. Adderley, Bart., M.P., through whose estate the contaminated stream flows, has obtained an injunction from the Court of Chancery to restrain the Corporation from continuing to poison this river. The nuisance arising from the sewage farm at Saltley has led to another injunction obtained by the inhabitants of the adjoining district of Gravelly Hill. As these injunctions forbid further delay, immediate action is imperatively necessary. Since there are no means of disposing of the sewage while it remains unpurified, some mode of purification must be found. The great question under discussion is, whether the Council shall endeavour to utilise the manurial properties of their sewage, or merely adopt means to purify the effluent water at the outfall. Between purification simply, and purification in conjunction with utilisation, lies a world of difference. Each system has its advocates. Most probably a middle course will be adopted. That is to say, it seems most likely that the Council will reply at present upon purification only for the bulk of the sewage, at the same time trying the gradual introduction of a complete system of utilisation. Whichever course they may adopt, the operations necessary will throw all previous experiments with sewage completely into the shade. On these points we shall keep our readers fully informed from time to time. At the present moment we shall content ourselves with examining the results of the Inquiry Committee's labours. We very much question whether anything like the same amount of reliable information on the sewage question has ever before been collected in any similar document.

The Sewage Inquiry Committee was appointed on the 6th July, 1871, "for the purpose of reporting to the Council as early as practicable their opinion as to the best mode of disposing of, or dealing with, the sewage of the borough, with power to engage such professional assistance as they may deem necessary, and specially to consider if it be possible effectually to exclude from the sewers all excreta and other animal and injurious matters that tend to cause the sewage, as now discharged, to become a common nuisance, together with an estimate of the cost of carrying into effect any proposition which they may submit to the Council."

The Committee report that "the population of Birmingham is 345,000, its area 8420 acres, of which 5870 are built upon, and the remaining 2550 are still under cultivation. The number of houses in the borough is about 73,200, giving an average of 59 persons to an acre on the area built upon, and nearly 4.7 to every house."

Eleven hundred and thirty-six houses and a few manufactories are drained into the small river Cole. With these buildings the report does not specially deal.

By the outfall at Saltley, where the nuisance has arisen, 72,087 houses, 6835 manufactories, 282 public buildings, 3203 stables, 154 cow-houses, and 292 slaughter-houses are drained.

The average dry weather flow of the sewage at the Saltley outfall is 17,000,000 gallons per day. The inquiry has shown that Birmingham cannot be considered a water-closet town, inasmuch as not more than 20,000 persons are thus accommodated, leaving 325,000 people dependent on the open middens with which the town abounds. The Borough Surveyor reports that these offensive receptacles expose an area of no less than 13¼ acres of putrescent matter in the midst of the population. Of the 19,551 middens at present existing in the town, great numbers are under workshops, merely covered by the boarded floors. These workshops are thus filled with the noxious exhalations from the filth lying beneath their floors. Analyses have shown that the water in the wells from which not less than 105,000 of the population are entirely supplied is, in reality, filtered sewage. No wonder, then, that the classes of disease induced by impure air and water are dreadfully prevalent in some quarters of the town. The report of the Registrar-General for the quarter ending June 30th, 1871, shows that the death-rate in All Saints Ward reaches 37.1 per 1000, while in Edgbaston it only reaches 13.8 per 1000. Both returns are the yearly averages for ten years, from 1861-70. In All Saints are concentrated the worst conditions for health to be found in Birmingham. Edgbaston, on the other hand, is the west-end of the town.

It will thus be seen that the Birmingham Council have before them a double task. They have to deal with their sewage in such a way as to meet the requirements of the Court of Chancery, and also to improve the sanitary condition of the town itself.

With a view to the collection of the most reliable information as to the present state of the sewage question, the Committee visited Liverpool, Bolton, Manchester, Rochdale, Leeds, Nottingham, and Hull. They also addressed a paper, containing 44 questions, to other towns. The report furnishes the replies sent by Banbury, Bedford, Bury St. Edmunds, Carlisle, Cheltenham, Edinburgh, Warwick, Wolverhampton, Rugby, and Romford.

These replies are too voluminous for quotation. Summarising them, the Committee says:

"That the answers appear to be unanimous on the following points:

"1. That the land improves greatly under irrigation.

"2. That, as a rule, no complaints are made of nuisance arising therefrom. In the few instances in which nuisance has arisen it has been the result of carelessness in conducting the irrigation.

"3. The health of the district where irrigation is carried on is not injuriously affected.

"4. Cattle thrive on the irrigated land, and no case of their being affected with entozoa has ever been heard of.

"5. No other manure has been found necessary for the crops, and the produce, both in quality and quantity, is very satisfactory.

"6. The water, after passing through the land, is purified in a satisfactory manner, and in one case cattle drink the effluent water."

From the information collected, the following table has been compiled, furnishing in a condensed form most valuable facts:—

Towns.	Population contributing to sewage.	Gallons of sewage per head per day.	Daily dry weather flow in gallons.	Daily flow in tons at 224 gallons per ton.	No. of acres irrigated.	No. of acres per acre.	No. of tons applied yearly per acre.		Crops cultivated.	Quality of soil.	No. of years experience.
Birmingham	345,000	49	17,000,000	75,000	250	...	...		Rye-grass and meadow	Sand	123
Edinburgh	96,000	...	...	...	110	...	...		Pasture	Alluvial	11
Carlisle ...	31,000	...	...	...	...	...	...		Rye-grass	Loamy clay, peat, and sand	1
Wolverhampton	68,000	37	2,500,000	11,160	330	...	...		Pasture	Clay	21
Cheltenham ...	40,000	25	1,000,000	4,464	130	121	4,037		Rye-grass and vegetables	Deep soil, with gravel subsoil	4
Bedford	16,800	36	600,000	2,679	26	199	7,830		Rye-grass	Light with gravel subsoil	6
Bury St. Edmunds	15,000	10	[150,000	670	135	677	9,400		{Rye-grass, vegetables, pasture, and small quantity of cereals}	Clay	24
Warwick... ...	11,000	48	[528,000	2,357	130	81	6,372		{Rye-grass, roots, and oats}	Stiff soil	4
Banbury	11,500	26	300,000	1,340	65	90	2,760		{Rye grass, vegetables, and small quantity of cereals}	Gravel upon clay subsoil	5
Rugby	8,000	25	202,000	902	121	123	5,065		Rye-grass and vegetables	Light with gravel subsoil	2
Romford	7,000	35	247,000	1,102		58	3,324				
						7	40,578				
					Average ...		5,768				

Remarking upon the facts disclosed by this table, the Committee draw attention to the following important considerations:—

"That it is impossible to draw any conclusion as to the number of persons whose sewage can safely be put on each acre.

"That the quantity of sewage capable of utilisation depends

"'1. Upon the capacity of the soil for absorbing moisture.

"'2. Upon the character of the plants grown thereon.'"

Rye-grass will consume more sewage than any other plant. After rye-grass come green vegetables. It is very noteworthy that at Bury St. Edmunds, where by far the largest quantity of sewage per acre is applied, there is no effluent water, the soil being so absorbent as to retain the whole of the moisture.

Judging from these figures, the committee say that not less that 4800 acres of land under rye-grass and green vegetables would be requisite for utilising the present outflow of the Birmingham sewage. Of course it would be impossible to find a market for the produce of this area of land under such crops.

It would, therefore, be necessary to adopt an ordinary routine of crops, and in this case it is probable that at least 10,000 acres would be required. Mr. Hope, of Romford, puts the area required at this moment as a minimum. It must be borne in mind that Mr. Hope's experience is more extensive than that of any one else in the practical question of making sewage irrigation a commercial, as well as a sanitary, success. Having regard to the enormous expense which would attend the immediate formation of a sewage farm for Birmingham, with the very great risk of failure, the Committee lean towards a simple scheme of intermittent downward filtration. With this view before them, they went to Merthyr Tydvil and inspected the filtration scheme which is being there carried out by Mr. Bailey Denton, C.E.

The Sewage Inquiry Committee have recommended the following scheme to the town council:

"1. The purchase of 500 acres of land for the purposes mentioned in this report."

(That is to say, for intermittent downward filtration.)

"2. To obtain borrowing powers for the purchase of land and execution of the necessary works.

"3. To obtain powers for creating perpetual annuities for such sums as may actually be expended upon the purchase of land, and distributing the repayment over 75 years of such sums as may be expended upon the construction of a conduit or other necessary permanent structural works.

"4. To obtain powers for leasing lands, and entering into agreements for supplying sewage to owners and occupiers of land."

The Committee have furnished the Council with the following estimate of the cost of carrying out their scheme.

CAPITAL ACCOUNT.

	£	£
Estimated cost of conduit, tanks, machinery, and other appliances, and of draining and preparing 500 acres of land, inclusive of compensation and other contingencies		190,000
Add 20 per cent. for interest during construction of works, commission, and other charges for supervision, &c.		38,000
Draining land at Saltley, say 100 acres, 6 or 7 ft. deep, at 8*l.* per acre		800
Cost of 800 acres of land by compulsory purchase, including Parliamentary charges, compensation, &c., at 120*l.* per acre		96,000
		324,800

INCOME AND EXPENDITURE ACCOUNT.

Expenditure.

	£	£
4½ per cent. interest, including repayment of principal in 75 years on 190,000		
38,000		
£228,000		10,260
Interest on 800*l.* for draining land at Saltley, including repayment of principal in 17 years, being the unexpired term of lease, say 7½ per cent.		60
4 per cent. perpetual annuities on 96,000*l.*, the estimated cost of land		3,840
		14,160

Income.

	£	£
Balance of income over current expenditure, on filtration and cultivation of land, being 4*l.* per acre on 500 acres for rent, use of sewage, and interest on expenditure in draining and preparing land ...		2,200
Rate proposed to be charged on water-closets, say, ...		3,000
Rent for sewage estimated to be supplied from conduit		2,000
Economy to the borough from proposed system of weekly collection, being saving on sales of intercepted excreta		1,000
		9,200
Estimated expenditure ...	14,160	
Income	9,200	
Annual loss	£4,960	

The Committee further suggest the gradual abolition of all middens. They recommend an extensive trial of the Rochdale and Manchester systems of privies, of which they furnish lithographic illustrations. These plates we shall take an early opportunity of reproducing.

They recommend the entire exclusion from the sewers of all excreta, animal and other putrescible refuse, except in the case of water-closets, upon which a special rate is to be levied.

A further recommendation is that all refuse from metal works, wire mills, manufacturing chemists, and any other, found to injure the sewage for irrigating purposes, be either excluded, or chemically treated before admission.

There are many other important points in this report, and in the valuable appendices containing the evidence of the witnesses examined. With these we hope to deal next week.

ENGINEERING OPERATIONS AT CHATHAM.

The annual inspection of field works at the school of military engineering, Chatham, was made on Tuesday last by H.R.H the Duke of Cambridge, accompanied by the officers of his staff. This display is always one of interest and instruction, affording, as it does, an insight into the most recent advances made in the details of military engineering. There are, however, generally some matters which may not be exposed to the curious gaze, and respecting which the inquiring mind can obtain no information. Certain details of the R.E operations are, to all but themselves, as a sealed book. On the present occasion this book might have contained particulars of the most recent practice in charging and firing submarine torpedoes, into which branch we understand several improvements have been introduced of late. But inasmuch as it is considered by the authorities that we are at the present time much in advance of other nations in this respect, they have wisely determined to remain so by withholding from the public all new matters of detail connected with the torpedo service. There were, however, several novelties connected with the science of military engineering which were open to inspection, and to these we will therefore direct attention.

The programme was a very full one, and was equally attractive. The operations comprised the firing of mines, countermines, and submarine torpedoes, the destruction of stockades by gun-cotton, the trial of pontoon bridges, and the attack and defence of the fortifications. Besides these items there were others referring to the inspection of various timber bridges, an observatory, and other structures of this class. Following the order of our inspection, we first note a railway trestle bridge in three tiers 63 ft. high, 190 ft. long, and built in spans of 20 ft. each. Next there was a single lever spar bridge of 50 ft. span, the distance between the supports being 80 ft., whilst near it was a double truss spar bridge of 80 ft. span, and 60 ft. between the supports. Then came a single truss spar bridge of 70 ft. span and 50 ft. between the supports, which was made by the officers of the military engineering classes, the previous bridges having been made by parties of sappers. Further on was a double lever bridge of 42 ft. span, made by sappers, whilst the mode of passing the frame of a flying bridge across a ditch was illustrated also by a party of sappers. An ingenious suspension bridge of 105 ft. span, formed of iron gabion bands, was also on the ground, but the principal structure of this class was a suspension bridge of 180 ft. span, which had been erected by 30 officers and 15 sappers, under Lieutenant Fraser, R.E., assistant superintendent of field works. The suspension cables were two strong iron wire ropes, the ends of which were well anchored in the ground. The wire ropes were carried over a square timber frame at each end of the bridge formed of poles lashed together, the platform being connected with the suspension cables by ropes and spars. Guy ropes were attached to the main wire ropes, and led away to the ground, where they were made fast. In order to show the efficiency of the bridge a heavy gun, with its carriage, was run on to the centre of the structure, and there left. The observatory was composed of spars, and had a platform 90 ft. above the ground level, and a flagstaff 45 ft. higher. Each of these structures possessed a special interest in connexion with the particular purpose it was intended to serve.

The inspection of these structures over, the siege operations commenced by the firing of two mines charged with 1000 lb. of gunpowder each. The effect in each case was to form a crater about 16 ft. deep and 50 ft. wide, in which the besieging party soon effected lodgments. Leaving them to convert the disrupted soil into effective works, from which to advance nearer to the fortress, we proceed to the destruction of timber works by gun-cotton. The first of these operations was conducted against four timber piles, placed vertically, and connected by transverse beams at the top to represent the supports of a bridge. Two of the piles, one measuring 14 in. by 14 in., and the other 16 in. by 15 in., were demolished by 12 oz. and 8 oz. of compressed gun-cotton placed in auger holes of 2 in. and 1½ in. diameter. The other two timbers, which measured 15 in. by 15 in., were cut clean through by necklaces of gun-cotton discs strung round them, the charges being 8 lb. and 8¾ lb. respectively. The destruction was complete, the ignition being effected by the dynamo-electric machine, with electric detonating fuses. A stockade was next attacked, with 40 lb. of gun-cotton and 100 lb. of powder. The stockade was a single one, and was composed of timbers 12 in. square, but a row of timbers was placed in its rear to protect the dockyard wall beyond from damage by the explosions. The gun-cotton cut clean through five of the timbers, making matchwood of them, and effecting a practicable breach. The gunpowder brought down seven timbers, but as they fell across each other in the breach it was rendered less practicable than the previous one.

The submarine mining was carried out under the direction of Captain Malcolm, R.E., and consisted, in the first

place, of firing six mines, which were laid across the river Medway. These charges were intended to illustrate what could be prepared for an enemy, and were exploded electrically from the instructional vessel Volta, which was moored off Hooness. In actual operations, however, the charge would be fired from a station on the shore. The quantity of gun-cotton in each mine was 50 lb., although the ordinary submarine mines contain from 100 lb. to 500 lb. of gun-cotton. The result was very effective, a succession of five *jets d'eau* being thrown up across the river. After these explosions H.M. paddle-wheel vessel Bustler steamed up the river over a submarine mine, which she passed harmlessly. A large raft, however, which she had in tow at a safe distance, and which represented an enemy's vessel in pursuit, was blown up in passing over the same mine, which contained 50 lb. of gun-cotton. This illustrated the command the operator possessed over engines of defence of the submerged torpedo class.

Attention was next turned to some experiments with pontoon bridges on the bathing pond, illustrative of the relative merits of the new service pontoon boat and Blanshard's cylindrical pontoons. The new boat was designed by the Royal Engineers' committee; it is in the form of a punt, and is made of Clarkson's material, which is a combination of light planking and canvas, united with marine glue. The platform of the bridge is carried at intervals on bearings formed in the pontoons, seven of which were used on the present occasion. Across this bridge a 64-pounder breech-loading gun, weighing 98¾ cwt., and carrying 78¼ cwt. on the hind wheels, was successfully drawn by men. Steam sapper No. 2, weighing 94 cwt., and carrying 73 cwt. on the hind wheels, was then run half way across the bridge and back again, after which it hauled back the 64-pounder gun across the bridge. After this the steam sapper, standing on shore, hauled an 18-pounder muzzle-loading gun, weighing 75¼ cwt., over a bridge, the platform of which was carried at one end on two of the new pontoons, then on two of Blanshard's pontoons at close order, and then on six more of the same pontoons at intermediate and open order. The gun passed safely over the new pontoons, as well as over the first pair of Blanshard's cylinders, but in passing over the next pair the safety of the structure appeared very doubtful. All doubt, however, ceased when the gun reached the centre of the bridge, as there the pontoon was submerged, the platform gave way, and the gun toppled unresistingly over into the pond. The superiority of the new punt-shaped pontoon over the old sheet-iron cylindrical pontoon was thus conclusively demonstrated. The remainder of the day was occupied with the operations of attack and defence, which were ably sustained, but as they involved no further points of interest to the majority of our readers, we refer the minority to the military papers, where they will, no doubt, be professionally recorded. One word of advice we would offer to the executive before concluding, and that is that when they require visitors to repair to the stations assigned them for viewing the operations, they will see that they are able to obtain ingress. When the operations commenced on Tuesday morning we found ourselves, with a large party of visitors, at the foot of the steps leading to St. Mary's casemates, the door of which was locked and sedulously guarded by a couple of policemen and a sergeant of engineers. The keys were nowhere to be found, and for nearly an hour the company, at both ends of the casemate, saw nothing, although they could hear well enough. The gates were in charge of the police, and the keys in that of the military, and both were kept very safely. At length, on the arrival of the police inspector, the gates were ordered to be taken by assault, and, after a brief resistance, they were taken with the material aid of a poker from the adjacent barracks. On the next occasion it will be as well to give both key and gate into the charge of the same custodian.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Railway Extensions at Mexboro' and Sheffield.—The Manchester, Sheffield, and Lincolnshire Railway Company are very largely extending their means of accommodation for the traffic at Mexboro', which has greatly augmented since the opening of the through line from Sheffield to Doncaster, &c. A passenger station of handsome appearance, and affording commodious facilities for its requirements, is in course of erection, in addition to the work in hand for the heavier traffic. An unfortunate and fatal accident happened at these new works on Wednesday last. The bridge over the river Don Company's canal, which was in course of erection for the approach to the station, fell in, killed one man, and seriously injured two others. The bridge was erected with a brick arch on stone foundations, the height being 30 ft., and the span 65 ft. The same company are also constructing extensive new sidings in Lumley-street, Sheffield, near their park station, in order to accommodate the overcrowded and continually increasing mineral, timber, &c., traffic at that part of their line. I am informed that the Manchester, Sheffield, and Lincolnshire Company are about to lay out a short loop, or curve, from a point near Darwall Station on their main line to the South Yorkshire branch railway, so as to run trains through without having to remake them up at Sheffield. The erection of new goods warehouses, &c., at Bridgehouses, Sheffield, makes but slow progress.

Meeting of the Sheffield Gas Light Company.—The thirty-third ordinary meeting of the shareholders in the Sheffield Gas Company was held on Friday last in the old Assembly Rooms, Sheffield. Mr. W. Lockwood, chairman, presided. A dividend of 10 per cent. per annum was declared on the class A and class B stock, and 7½ per cent. on the new 10*l.* shares (2*l.* paid up per share). It was also mentioned that the directors thought they would make a call, payable on December 31st next of 1*l.* per share, and probably another on June 30th, 1872. Several shareholders asked questions relative to the "new gas" (the oxyhydrogen light) relative to which paragraphs have gone the round of the daily papers; one gentleman thought that some day or other "something" would be found to supersede coal gas, and he hoped the managers would be alive to what was going on. The engineer (Mr. Herbert Unwin) said he knew nothing as yet about the new light referred to, having had no opportunities of inspecting it.

Further Extension of the North-Eastern Railway System.—The North-Eastern Railway Company will at once commence the construction of a line from Knaresborough to Borough Bridge. It will commence near the goods warehouse at Knaresborough, and will terminate by a junction with the Borough Bridge branch of the North-Eastern system, near Borough Bridge station. It will be about 7 miles 22½ chains in length, and the engineering features are not very remarkable.

Proposed new Railway in North Lincolnshire.—Several public meetings have been held at Louth and other towns in favour of a proposed railway from Louth to Mablethorpe, with a branch to Saltfleet. It appears that a correspondence on the subject has been conducted between the promoters and the Great Northern Company, and that the latter are willing to work the line on the same terms as the Louth and Lincoln—that is, 50 per cent. on the profits. Messrs. Robinson and Shelford, London, are the engineers, and Messrs. Dixon and Lucas, London, the solicitors, who have the matter in hand. The scheme appears likely to be successful, and the proposed line would undoubtedly break up new and profitable ground.

Extraordinary Meeting of the Sheffield Water Works Company.—A special meeting of the shareholders in the Sheffield Waterworks Company was held in the Cutlers' Hall, Sheffield, on Monday, for the purpose of considering the propriety of the company borrowing on mortgage the sum of 55,333*l.* 6s. 8d. (one-third of the 166,000*l.* which the company is authorised to borrow under their act of 1867), or any part of such sum, and to authorise its disposal. Resolutions to that effect were unanimously passed. It was stated that there is about 40 ft. of water in the New Strines reservoir of the company.

New Bridge at Halifax.—The new North Bridge at Halifax was opened this morning with considerable ceremony. The structure has cost about 50,000*l.*, and is a fine piece of work. A banquet, to which many celebrities, local and general, are invited, is to take place this evening.

The Cyclops Steel and Iron Works.—Referring to a paragraph which appeared in these Notes last week, to the effect that it was supposed on good authority that Messrs. Cammell and Co. contemplated the erection of new iron and steel works, at Heeley, near Sheffield, we are requested to state that the company have made no purchase of land at Heeley, nor is it their intention to erect new iron and steel works.

NOTES FROM THE SOUTH-WEST.

Gloucester and Berkeley Canal Company.—The report of the directors of this company just issued to the shareholders states that the amount of business done at the port during the past half-year has been very large, and that the revenue receipts have been in proportion. The expenditure includes, under the head of a steam launch, the balance of an amount for which the alternative of a suspense account has been adopted, and 400*l.* is thus reserved for gradual liquidation. This arrangement leaves a balance on the half-year of 746*l.*, admitting of a dividend for the half-year at the rate of 4½ per cent. per annum. Mr. Clegram, the engineer, states in his report that the works in the east branch of the river at Llanthony are nearly completed, while those at Maisemore are just approaching completion, and that enough has been done to prove the value of these works to the navigation. Two culverts for diverting the Holly Hasle and Dinmore Hills, between 2000 ft. and 3000 ft. in length, have been completed; the greater part of the puddle round the lock and tidal basin has been put in; about 156,000 cubic yards of earthwork, considerably more than a fifth of the whole quantity, have been removed; and a large earthwork or dam has also been made on the Severn side across the mouth of the new entrance to keep in the Severn water during the execution of the works. The engineer suggests an extension of these works, the cost of which he estimates at from 12,000*l.* to 13,000*l.*, and the directors express their concurrence in the suggestion.

Railway Iron for Austria.—The Woodham, screw steamer has cleared from Cardiff for Trieste with 1100 tons of railway iron supplied by the Rhymney Iron Company.

Sewage at Taunton.—Mr. Sutton, of the Exeter Sewage Company, has offered to take the sewage of Taunton for a number of years, and then to hand over the works and land upon which they are erected free of cost. Nothing definite has yet, however, been arranged upon the subject.

A Strike in the Forest of Dean.—The Park End Company's colliers have been on strike for some time in regard to the system under which coal is weighed at the bank. The strike is unfortunately causing great loss, and the men still show a decided determination to persist in their demands.

Merthyr Sewage Farms.—On Friday morning, the Rivers Pollution Commissioners—Dr. Frankland and Mr. J. C. Morton—with their secretary, visited the Merthyr sewage farm in the Troedyrhiew Valley. They were accompanied by the chairman and the officials of the Local Board of Health. A minute inspection was made of a 20-acre patch, on which are grown cabbages of all kinds, turnips, mangolds, &c., the plots being covered with vegetables of very considerable size. Sewage was introduced into the main carriers, and its subsequent course to the branch carriers and down the innumerable furrows, was watched with much interest. Samples of water before its inlet to the main carriers were taken away every half-hour, for the purpose of testing. Having traversed the productive plot, the party arrived at the further end—the outlet—where an abundant stream of sparkling water appeared to testify to the efficiency of the system adopted. There, as at the inlet, samples were taken every half-hour, and not a few ventured to sip from the stream, which was by no means unpalatable.

Taff Vale Railway.—The traffic of this line once more shows its old tendency to increase. The aggregate decrease this half-year is, however, about 20,000*l.*

Water Supply of Aberystwith.—The Aberystwith Improvement Commissioners have resolved to apply to Parliament next session for powers for the improvement of the water supply of the town. Mr. J. W. Salumper, C.E., and Mr. W. Thomas are to take the necessary measures for the preparation of the bill which will have to be introduced on the subject.

Trade at Cardiff.—The steam coal trade is considered to have improved at Cardiff. The Marquis of Bute has leased 15 acres of land for the erection of large copper smelting works to the Tharsis Copper Ore Smelting Company.

Pontypool, Caerleon, and Newport Railway.—The works on this line have been commenced, but are not expected to make any very decided advance until the spring. Nearly all the land required has, however, been obtained, and next session operations will be carried on with a will.

Crumlin Viaduct Works.—These works, carried on for a lengthened period by the Kennard family, are about to be transferred to a limited liability company. The capital of this new concern will be 50,000*l.*

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the attendance on 'Change at Middlesbrough was larger than on the previous market day, and business was lively. As has been the case for some time past the demand for all kinds of pig iron far exceeded the supply, and as a natural consequence the ruling prices were easily obtained, the market closing firm. Many of the makers still find it difficult to satisfy the requirements of their customers.

The Finished Iron Trade.—In every branch of this great trade there is activity, and as the wages question has been settled on the conditions we published last week, the men are working satisfactorily. All the rail makers continue busy, and the plate and angle makers are in the same condition they were in a month ago; they cannot get through their work quick enough. Bars, billets, hoops, sheets, wire, nuts, and bolts find a ready market.

Engineering.—Since the settlement of the strike in Newcastle for the nine hours' movement orders have come quickly in to all the engineering establishments on Tyneside. Indeed all the shops of the North of England are exceedingly busy. There is a large number of locomotives being made and the marines are so much sought after that the order books are full for some time to come.

Shipbuilding.—On the Tyne, Wear, Tees, and Humber shipbuilders are full of work. Most of the great steam shipping companies are rapidly extending their business and are increasing their fleets. In consequence of this the demand for steamers of all sizes is heavier than ever.

The Saltburn Pier Company.—This company held their annual meeting at Saltburn a few days ago, and paid a dividend of six per cent.

Middlesbrough and More Railway Communication.—Yesterday, at a meeting of the Middlesbrough Chamber of Commerce, this important question was again under discussion. The following report was read: "The committee appointed in connexion with Mr. Breckon's proposal for improved railway communication between Cleveland and East Durham, have held two meetings. They have placed themselves in communication with the North-Eastern Railway Company, and have learned from them that they propose to apply this session for Parliamentary powers to construct a new line of railway from Wingate direct to Hartburn, so as to form a short convenient, and almost direct railway between Cleveland and the colliery district, north of the old Hartlepool railway. They have been informed that in view of the arrangements which the North-Eastern Company propose to carry out, and by which the northern collieries will be from eight to nine miles nearer than by the existing lines, the coal owners do not propose to continue their efforts for making a new line. They prefer to effect a connexion with Sunderland, by making the existing colliery lines into a continuous railway, which may be eventually used for public purposes. The committee find that the scheme of the coal owners, which includes crossing the Tees about midway between Stockton and Newport, would place Middlesbrough about two miles nearer to the northern coal districts than the proposed new works of the North-Eastern Railway would do, the committee therefore recommend that a communication be sent to the North-Eastern Railway Company urging upon them the desirability of making the connexion between the banks of the Tees at the point shown in the accompanying plan." The Chamber expressed its satisfaction with the North-Eastern Railway Company's scheme, and hoped that the details would be so satisfactory that they could support it before Parliament. A few days ago another scheme for improving the railway communication of Cleveland was mentioned by the *Newcastle Daily Chronicle* as follows: "A scheme is being organised to open out the splendid ad-

vantages of the extensive coalfield which lies between Seaham Harbour and the Hartlepools, by the construction of the once mooted coast line to connect Sunderland, Seaham Harbour, the Hartlepools, and Middlesbrough, the latter place, with Stockton, to be connected with it by a tunnel beneath the bed of the Tees, at a point at which we are assured the difficulty will neither be serious in an engineering or pecuniary point of view. This line it is proposed to connect with the main line of the Midland (Settle and Carlisle section) by means of a direct line, running almost due west from a point near to the Hartlepools, passing through Darlington to the Hawes Junction on the above section of the Midland line. It will be about fifty miles in length, and will establish a direct highway between the busy commercial centres of Lancashire and north-west Yorkshire, the great Cleveland district, of which Middlesbrough is the centre, and the rising port of the Hartlepools." It is quite clear that the Cleveland district is developing so fast that additional railway communication must be given to it either by the North-Eastern Company or some other company.

The Opening of the Newcastle College of Physical Science.—This excellent college was formally opened yesterday. It is very gratifying to be able to state that the college starts with an annual income of 900*l.* Only six months ago the project was first agitated, and the subscription list was handsomely filled. About 14,000*l.* has been received. A great deal more will be required, but from the spirited manner in which the people of the North of England supported the scheme for establishing a college when it was mooted, we have no doubt that all the money requisite for carrying on such a scholastic institution in a proper manner will be forthcoming.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—During the past week there has been a firm market and a large amount of business has been done. Since this day week prices of warrants have risen about 1s. 7d. per ton, and there has also been a rise of 1s. all round in the price of makers' iron. The improvement which was showing itself last Wednesday was continued on Thursday when, at the close, sellers were asking 61s. 11d. cash, and 62s. 2d. one month. There was a slight additional advance on Friday; but on Monday, when it was known that the shipments of the preceding week had been very large, there was an advance to 62s. 6d. cash, and 62s. 9d. one month, which were the top prices, sellers at closing asking 62s. 6d. cash, and 62s. 9d. one month, buyers 1d. less. The top prices realised yesterday were 62s. 9d. cash, and 63s. one month, but there was a little slackening at the close. The best prices of yesterday have been maintained to-day, and sellers have been asking a further advance. The following are the quotations for several brands of makers' iron: No. 1 Coltness, 74s., No. 1 Gartsherrie, 73s., No. 1 Summerlee, 70s., Glengarnock 69s., Langloan 68s., No. 1 Calder, Shotts, and Chapelhall, 67s., No. 1 Carnbroe, 66s. 6d. In most cases makers have but very low stocks just now, and it is with difficulty that they can supply all the demands made upon them. Since the beginning of the month between 2000 tons and 3000 tons of pig iron have been withdrawn from public stores, and additional orders are being received by the store keepers. Last week's shipments were, foreign, 15,689 tons; coastwise, 6203 tons; total, 21,892 tons; corresponding week last year, 14,298 tons; increase 7594 tons; total since 27th December, 1870, 672,651 tons, being an increase for the year of 160,830 tons. Preparations are being made with the view of increasing the make of pig iron in Scotland.

The Malleable Iron Trade.—This branch of trade continues to be in a very prosperous condition. There is no actual advance in the price of malleable iron, but the mills are all busy, and the tendency is to higher prices. Common bars are quoted at 8*l.* 5s. to 8*l.* 10s., angle iron at 8*l.* 15s. to 9*l.*, ship plates from 10*l.* 10s. to 11*l.*, boiler plates from 11*l.* to 11*l.* 10s.

New Contracts for Works.—I understand that Messrs. McIntyre and Thomson, of Glasgow, have been successful in their tenders for the erection of the dynamite factory, which the British Dynamite Company are about to erect at Irvine, on the Ayrshire coast, and for the new gas works which are to be built for the Greenock Corporation Gas Commissioners. The contract last referred to will be upwards of 13,000*l.*

The Albert Bridge, Glasgow.—At a meeting of the Glasgow Bridge Trustees, held this day, it was reported in respect of the Albert Bridge, lately erected in room of the old Hutchesontown Bridge over the Clyde, that the whole works had been completed in a thoroughly efficient manner, and to the complete satisfaction of the engineers. Furthermore, it was reported that they had been finished within the original estimates. The net sum of the tender was 54,000*l.* 11s. 3d., but that was reduced to 52,108*l.* 8s. 6d., after deducting the value of the materials of the old bridge.

Glasgow Tramways.—The Tramways Committee reported to a meeting of the Glasgow Town Council to-day that they had had under consideration a proposed alteration in the gauge of the tramways, before proceeding to any extent with the works. This alteration was rendered desirable from the circumstance that the Vale of Clyde Tramways Company were making the gauge of their tramways of sufficient extent to admit of railway trucks passing along their lines, and as these tramways joined the Glasgow ones, the gauge of which were about three-fourths of an inch smaller, it was desirable that the gauge of the latter should be altered, so as to prevent the necessity of a stoppage of the traffic in being transferred from the one line to the other. The consent of the lessees was necessary in order to effect the alteration, and it was confidently expected that the lessees and the committee would be able to come to an arrangement about the matter. In connexion with this subject it may be mentioned that an experiment was made this forenoon on a siding in the pig iron yard of the Glasgow and South-Western Railway station to test the feasibility of running railway stock on the tramways. The trial was perfectly successful, the wheel flanges of the truck running easily and smoothly in the grooves of the tramway rails. The gauge required is 4 ft. 7¼ in., or ¾ in. less than the railway gauge. The importance of this arrangement cannot be too highly estimated, as it will enable shipbuilders and others to have sidings into their yards, so that coal, iron, &c., may be delivered to their hand at a merely nominal cost.

Greenock Water Trust.—At the usual meeting of this Trust held yesterday, the superintendent reported a supply of water in store for all purposes equal to six weeks' consumption, or 117,830,069 gallons. The minutes of the finance committee bore that Fall No. 14 had been let to Messrs. Fleming, Reid, and Co., at the same discount for eight years as for Fall No. 13, the allowance of the water to be 3000 cubic ft. per day. The quantity of water supplied for manufacturing purposes is still increasing, and the arrangement recently come to for supplying large quantities of brown unfiltered water at the low rate of 1d. per 1000 gallons, will tend to increase it still further, and make Greenock a very suitable place for all public works requiring large supplies of water for condensing or other purposes.

The Shipwrights' Strike and Lockout.—The dispute between the Clyde shipwrights and their employers is now at an end, and the men have returned to their work in large numbers at the advance in wages granted by the employers. One of the largest of the Greenock firms has given the same wages. The men are very much opposed to overtime, and before going in last Thursday they resolved that they would refuse to work overtime unless paid time and half for it.

The Edinburgh Tramways—Completion from Haymarket, Edinburgh, to Bernard-street, Leith.—The lines of tramway from Haymarket to Bernard-street, Leith, by way of Leith-street, were completed on Thursday. Mr. Gowans, the contractor, has completed this part of his work seven weeks before the time agreed upon in the contract, according to which he claims 200*l.* for every week the tramways are in a complete state before the 30th of November. The company appear to be going to prosecute the construction of the tramway to Portobello with as much energy as the lines just completed. A slight beginning has already been made in Waterloo-place. It is expected, if not definitely determined, that this first section shall be opened for traffic on Wednesday next, 1st of November. The Edinburgh tramways have been laid on a bed of Portland cement concrete. The rails, which weigh 52 lb. to the yard, are laid on longitudinal sleepers, firmly rivetted together by iron bars, the sleepers being of red Baltic fir impregnated with creosote. A number of the cars have already arrived on the ground. They are made at Greenwich.

The First Cylinder of the Tay Bridge Placed.—On Wednesday last, the first cylinder—one of the two forming the base of the fifth pier—was safely lowered to its right position in the river. The whole process of lifting, shipping, and lowering the cylinder—including metal and brickwork, weighing upwards of forty tons—went on without the slightest hitch, thus demonstrating the practicability of the new system of sinking piers. The process being quite new in this quarter, the contractors purposely conducted it deliberately and with circumspection; but they are confident that when the workmen acquire a little experience they will be able to carry the cylinders from their place of construction in the temporary harbour and lower them into their right positions in the river in one tide.

The Oldest Steamer Afloat.—There is at present at work on the Aberdeenshire coast a steamer named the Stirling Castle, 51 tons register, which is said to be the oldest steamer afloat. She was built in the year 1826, for the Forth passage to Sterling, on which a steamer was engaged as far back as the year 1813.

A Granite Lighthouse for Ceylon.—A lighthouse, all in Dalbeattie granite, intended to be erected by the Trinity Board at Point de Galle, Ceylon, is now almost completed by the contractors, Messrs. Shearer, Smith and Company, Dalbeattie Granite Quarries, who are now setting the final portion of it. It contains about 20,000 cubic feet of granite.

FOREIGN AND COLONIAL NOTES.

American Gold and Silver Mining.—The value of the gold and silver produced annually upon the Pacific coast of America is now about 16,000,000*l.* During the last 20 years the value of the precious metals brought into circulation by mining and exploratory operations on the Pacific coast has been about 240,000,000*l.*

Roumanian Railways.—The contractors for the Roumelian branch line from Salonica to Uskup hope to open the line for public traffic by the middle of next month as far as Karrasoule, a distance of 56 miles. Twenty locomotives and and a quantity of other rolling stock are expected shortly at Salonica for the service of the line.

The Suez Canal.—Between Port Said and Kantara the depth of water which can be relied on at present is between 23 ft. and 24 ft., and patches of the same depth are found in other parts of the canal; but wherever these patches occur a dredge is always at work in the vicinity. The channel through Lake Timsah is completed to a depth of between 27 ft. and 28 ft., and the dredging of the anchorage space on the lake will shortly be completed.

The St. Louis Canal.—When the French port and canal of St. Louis are completed, it is expected that the coal of the South of France will acquire a greatly improved position upon the Mediterranean markets. The canal branches out of the Rhone a little below Arles, and it terminates to the east of the delta of the Bouches-du-Rhone; it will thus put the navigable part of the Rhone in direct communication with the sea.

Expansion of the American Mail Service.—The American Post Office department is widely extending its mail service over the United States, and it is especially active in taking advantage of the improved facilities offered by the expansion of the American railway system. At the close of June, 1871, there were over 50,000 miles of railway postal routes in operation as compared with 34,000 miles at the close of June, 1868, and during the fiscal year 1870-1; the number of miles of railway over which American mails were carried was 107,000,000, showing an increase of 32 per cent. over the corresponding number of miles in the fiscal year 1867-8.

The Belgian Iron Trade.—Metallurgical industry in Belgium remains in a favourable state. Miscellaneous descriptions of iron continue to advance, and the various establishments remain actively at work. An exception to these remarks must be made, however, in the case of rails which are in comparatively sluggish demand.

Steamers at Montreal.—The people of Montreal are somewhat apprehensive lest the importance of the town as a seaport should be injured by the constantly increasing size of the ocean mail steamers. The Sarmatian of 3600 tons burthen was on her first voyage compelled to unload at Quebec owing to the impossibility of getting much further up the river. In order to meet the requirements of the case the Montreal Harbour Commissioners have determined upon the enlargement and improvement of the channel. It will be necessary to make it more than 24 ft. deep.

Revenue of the Suez Canal.—The revenue of the Suez Canal Company for September is returned at 37,044*l.*, as compared with 19,094*l.*, in September 1870, showing the large increase of 17,950*l.* The number of ships passing through the canal in September is returned at 48, as compared with 28 in September, 1870.

Shipbuilding at New York.—For many months past shipbuilding industry has been very greatly depressed at New York. Of late there has been some revival in affairs, but it is not regarded as permanent. The builders attribute the prostration of their trade to three causes, the high taxation of everything which enters into the construction of a ship, the furore for iron ships, and the construction of great railroads from the Atlantic to the Pacific. The business of repairing vessels has also been lost to New York by workmen's strikes for higher wages.

Pascoyd Iron Works.—These works are located at the Falls of the Schuylkill, near Manayank, Philadelphia, on the line of the Philadelphia and Reading Railroad. The management makes a speciality of rolled and hammered car and locomotive axles and line shafting. The working force has been of late 220 men, and there are 14 puddling and five heating furnaces, three 3000-pounds steam hammers, and one 1000-pounds steam hammer. The works turn out 1200 axles per week, and 3000 tons of shafting annually.

Dutch Steam Navigation.—The representative in Australia of the Netherlands India Steam Navigation Company has been in communication with some of the Australian Governments with respect to an improved mail service. The proposal made by the gentleman in question (Mr. A. Fraser) is that a monthly steamer should leave Batavia, plying *vid* Torres Straits to Moreton Bay, Bowen, and Sydney, making the last port the terminus. Arrangements could also be made, if desired, for the steamers to call at Port Darwin, so as to afford regular communication with North Australia. It is considered that three steamers could work the service. They would be steamers of upwards of 1000 tons each, fitted with compound engines, and working, say, 9 knots per hour. A subsidy of 27,000*l.* is solicited from the Australian colonies, to be divided among the various Governments, as may be deemed most advisable.

Rolling Stock for the Intercolonial.—Preparations for the equipment of the Intercolonial Railway with rolling stock have now made considerable progress. Contracts have been entered into for the supply of 40 locomotives, 250 box freight cars, and 150 open or platform freight cars. The contractors for the locomotives are as follows: Dubs and Co., Glasgow, 15 engines, at 11,000 dollars each in bond; the Canadian Engine and Machinery Company at Kingston, 15 locomotives, at 12,500 dollars each; and Messrs. W. Montgomery and Co., Halifax, 10 locomotives, at 12,500 dollars each.

The St. Gothard Tunnel.—Prince Bismarck appears to have given his *imprimatur* to the St. Gothard tunnel project. He has also shown himself favourable to the granting of a subsidy by Germany, but the exact amount of it has not yet been determined.

New Zealand Steam Navigation.—A river steam navigation company has been formed at Auckland. The capital proposed at present is only 5000*l.* The object of the company is to connect the various New Zealand settlements by regular water communication.

Coal in Western Virginia.—It is stated that coal strata exist in Fayette County, in Western Virginia, which are at least 40 ft. thick. Such strata would, it is calculated, yield 1,000,000 bushels of coal per acre. If this statement is correct, Western Virginia ought to come to something some day.

CARTRIDGES FOR HEAVY ORDNANCE.—The cylinder or cartridge cases for heavy ordnance for use on board ships and in the field are now made in the Royal Carriage Department, Royal Arsenal, Woolwich, of a new composition, instead of leather as formerly. This material is composed of cork, canvas, thin leather, and india-rubber solution, and is found to be more suitable for the purpose than leather. A number of the cases have been subjected to an exhaustive trial, and the result has decided the superiority of those made of the composition, not only because they are much stronger, but also because they return to their former shape however much knocked about. They are also considerably lighter than the leather ones, and waterproof. The cases for 8-inch cartridges weigh 6¼ lb.; 9-inch, 7¼ lb., increasing in weight for every additional inch 1 lb.

MACHINERY FOR BENDING AND FLANGING PLATES.

CONSTRUCTED BY HERR A. LISMANN, ENGINEER, MUNICH.

FIG.11.

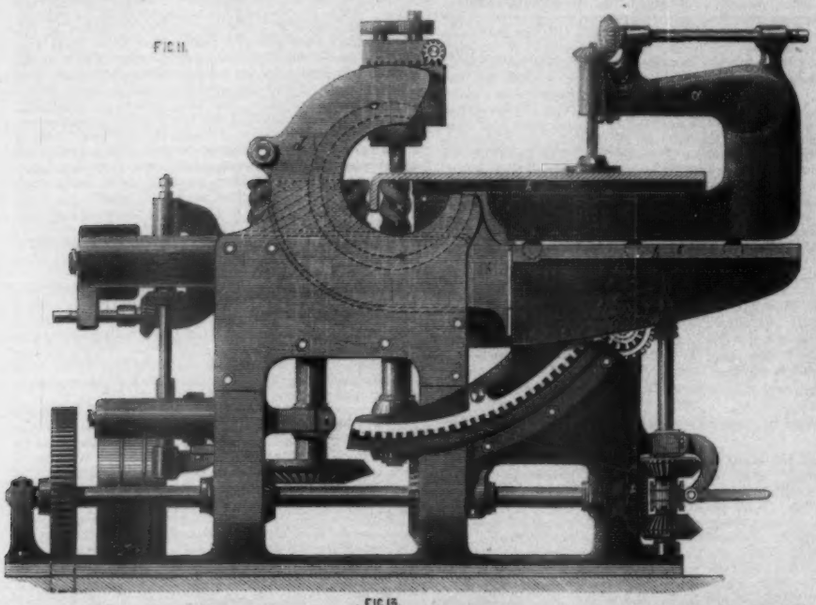


FIG.12.

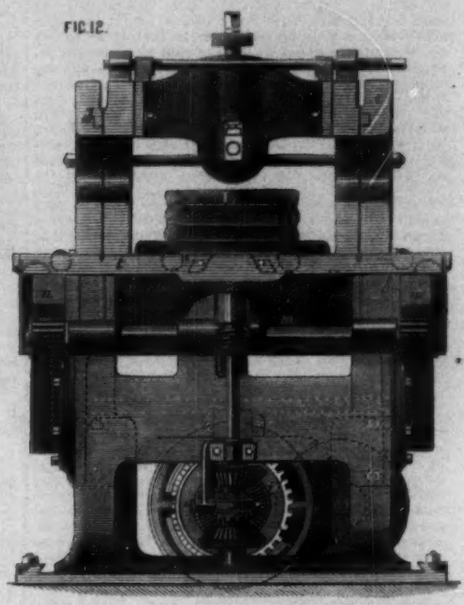


FIG.13.

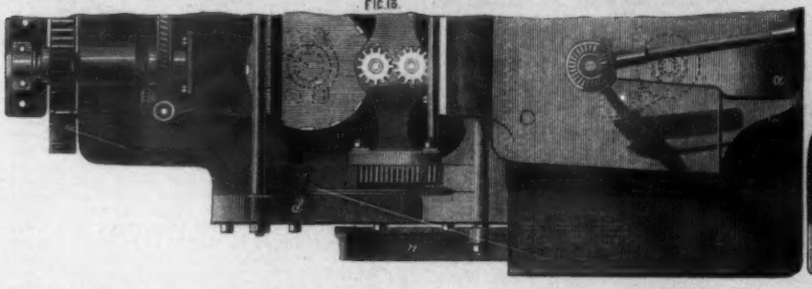
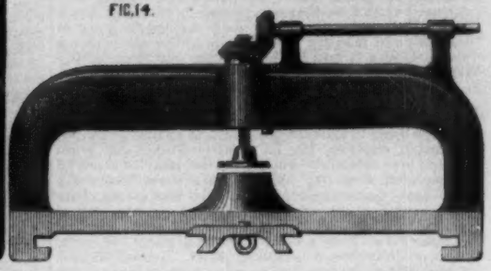


FIG.14.



On a recent occasion* we referred to several different forms of machines introduced by Herr A. Lismann for bending and shaping plates. We illustrate, above, another of his machines devised for the same purpose. In this arrangement the vertical axles are provided with rollers of different diameters, which receive the same velocity on their circumferences by means of bevel gearing. The plate to be bent is fastened to a template, shaped according to the form desired, but is as much smaller as the constant distance of the periphery from the inner edge of the bent plate, which in the drawing is equal to the diameter of the small roller plus the diameter of the roller, *g*. The template with the plate to be bent has a universal movement by means of the balls placed upon the table, *t*, to which is fastened the friction roller, *g*, which acts as a guide for the template, *h*. The whole table, with the template, the friction roller, and spindle for fastening the plate to be bent, is movable around the centre, *s*; for this purpose, and in order to allow of large-sized plates being bent, the segmental slides, *d* and *e*, are connected with the two sides of the table. These slides carry the horizontal and vertical reversing pressure roller, *f*, which prevents the plate from bending during the operation of bending.

The circular motion of the table is effected from the main shaft, by means of the bevel and reversing gear, *i*, *k*, *l*. Transferring motion by means of a worm wheel and screw to the horizontal shaft, *m*, the pinion fastened on this latter shaft gears into the segmental racks, *n*, *n*, which are connected with the table and impart a circular motion. In order to prevent lateral oscillation of the table the racks, *n*, *n*, move in guides. The plate to be bent is fastened to the template, *h*, the latter is brought up to the rollers until they catch a corner of the plate previously bent; the rollers revolving draw plate and template forward, and the former is bent to the figure, while that of the latter is transferred to the plate. With the arrangement shown in Fig. 4 circular plates may be bent, and by a slight modification flanges may be rolled upon cylinders.

Hamburg Steam Navigation.—The agents of the Hamburg-American Steam Packet Company in New Orleans, have intimated to the United States Postmaster-General that the company has decided to recommence running a line of steamers between New Orleans and Europe, touching at Havana, Cuba, and Santander (Spain). The company asks for the privilege of carrying the American mails for Havana and Spain, and this privilege the United States Postmaster-General will probably grant.

* See Engineering, p. 234 of the present volume.

ENGLAND AND INDIA.

To the Editor of Engineering.

Sir,—May I ask the use of your columns to have the opportunity of going from the regions of "visions" to the regions of realities? It seems like the return of visions to me when I see the attention now being given, even by the Prime Minister of England, to the matter of a railway from England to India; remembering that twenty years ago when I originated the Sinde Railway at a public meeting at Kurrachee, I ventured to draw attention to the great necessity of seeking out a new route to England *viâ* Persia and Turkey, particularly describing the now better known "Euphrates Valley route to India." Such are the vicissitudes of professional life connected with the East, that those schemes with their profits have fallen into other hands. While this agitation is going on, it will be only just that the real originator, the Right Honourable Austen Layard, should not be forgotten. Long before any of those who are now putting themselves forward as the originators of these schemes for railways to India, indeed, before some of them were born, that very distinguished Eastern traveller and antiquarian, wrote ably and enthusiastically in the *Morning Chronicle* and in several quarterly reviews and periodicals, facts connected with the subject bearing on the geographical and scientific points of the question which were only known to himself. Another Eastern traveller, the Reverend Mr. Badger, must not be forgotten; that amusing gentleman may really expect to see in reality, his humorous account of the railway porter at the Bagdad station calling out on the railway platform, "Bagdad, Bagdad, change here for Babylon!"

It is not unlikely that the Euphrates Valley Parliamentary Committee may next session find the whole matter of railways between England and India pressed upon their notice. I can count up no less than ten distinct schemes put forward; some of these are indeed visions, which can boast no more authority for their practicability or their ultimate political or commercial profit than a tunnel would be between America and Ireland. I am speaking only of the lines in the East, not of lines to the East. I will not doubt that Mr. Hamilton Fulton could build a bridge between Dover and Calais if he had the money, nor will I doubt but that Mr. Remington could form a tunnel between Dungeness and Cape Grisnez, if he had the same necessary beginning, with his shafts to enable the passers-through to rise up like whales and fill their air-blubbers and proceed on their journey. They are all honest projectors, and believe in the practicability of their schemes; they are honest enthusiasts, and deserve praise for their zealous advocacy; they must not be daunted, but keep themselves zealously before the public, bring out facts connected with their schemes on every opportunity, and must not be disheartened because other schemers show them up. When I proposed the Sinde Railway, the public newspapers in India said I was a madman; when I said at a public meeting in Kurrachee that I believed before I died I should see a telegraph wire round the world, I did so, as the newspapers reported, amid the "loud and prolonged laughter" of the intelligent audience; in the chair at that meeting sat no less a man in public estimation than the Commissioner of the Province, the present Sir Bartle Frere. Have I not, then, some right to tell these enthusiastic projectors, who seem to laugh at miles' length of mountains, and expect by means of some fairy wand a ready-made "embankment" along the banks of the Euphrates, to hope on, agitate on, as I did for five years before the necessity of the Sinde Railway would be recognised, though that line, or a line through the country which it passes, is now represented as an essential part of a railway from England to India? Have not all these projectors reason to go on and never flag, when for "fourteen years," in opposition to money and talent, I have stood by one line known as "Wells's Direct Indus Valley Railway," proclaimed all others wrong, while thousands and tens of thousands of pounds have been thrown away in trying to prove other lines should be made, and now, when time has almost done its worst for me, the Indian newspapers are all declaring I was right? I tell these projectors, then, not to falter, but push on; they must, one and all, expect to see trumpery and preposterous schemes get money and be recklessly and lavishly spent, while the real good and proper scheme is lost sight of and neglected, but they may rest assured truth will prevail in the long run. They are starting from a point which is a fact, that is, a railway from London to Calcutta, Hong-Kong, Pekin, and Yokohama is required. I am again a projector of a railway in the East, and I believe before any railway between the Mediterranean and India is made, my line will be first constructed. I propose to make a railway from the head of the Persian Gulf to Teheran and the Caspian Sea, with a branch to Ispahan, and am prepared to give "running powers" over it to the Direct Indian Railway Company (Limited), for the purpose of carrying their material into Persia. This is no scheme of a line from Bushire *viâ* Shiraz to Teheran—I know that route, its mountains and its deserts. I propose to start below the junction of the Euphrates and Tigris, and go through the richest provinces of Persia, thus bringing former fruitfulness back with population. I mean it also as a "move" upon the political checkboards, and to make Persia a strong country, as well as to show her by English justice, liberality, and science that we are the people for her to trust and encourage.

You may ask if I have any reason to believe in the necessity of this line. I have. After the Persian war was over in 1857, and the Commander-in-Chief, General John Jacob, returned disappointed, through peace being proclaimed, of his opportunity to add to his Indian renown, he entered upon the matter to me, explained the great mistake that was made in going to Bushire; that possession should have been kept of the rich populous districts through which my railway would go, and he said if the war had gone on it was his intention to have done me the honour of applying to Government for my services to survey and lay out the line gradually as the army advanced into the interior, and he said, some day the Government would find out they never ought to have left the country without receiving guarantees from Persia and Turkey that *every* one connected with the project should be protected, and he would have left a regiment of his own Sinde horse, recruited from the country people, to have acted as police in the country. With the Suez Canal open, and this line of mine made, an army could in less than a month be transported into the heart of Persia, and Russia be kept in check, and if at any time it be thought advisable a fleet of gunboats could be placed upon the Caspian Sea. If a repetition of the Persian troubles of 1856-57 should occur the first thing the English Government would have to do would be to send railway material to the point I propose to start from. Let us anticipate such troubles, and by anticipation prevent them, by sending locomotives and civil engineers, make roads and railroads before we consent to send English officers who have been applied for by the Shah of Persia to command his soldiers.

It may be thought, in my maturer age, I have lost some of the enthusiasm that was my characteristic for some years in India, when I try to put off the direct London and Calcutta Railroad, originated by Sir Macdonald Stephenson. It might be thought I am forgetful of the bird-nesting scenes of the Malay Archipelago, where I have seen the natives hanging in the air by what seemed threads, while they chiselled the rocks overhanging the ocean to get their prey; when I say that upon the promontories reaching out into the Persian Gulf and Arabian Sea Messrs. Low and Thomas, with a guarantee for forty millions, will find such a necessary means of cutting galleries on such rocks for a railway rather a weary, uncomfortable, and disheartening duty, and I am afraid the result of "measuring up the work" would give a very unsatisfactory "progress report" to the shareholders. Let them, however, go on between "Tricste and Aleppo," who knows what may be done by able Englishmen with their hearts in the right place? All honour, I say, to the daily and scientific journals which allow the agitation and ventilation of these schemes, for they lead to the puffing locomotive taking the place of the deadly roaring cannon.

Messrs. Low and Thomas may have visions of travelling at the rate of "75 miles an hour," and driving the engine that is to draw the Governor-General of India, with a through ticket in his waistcoat-pocket, to the seat of his Government, despising, like his great forerunner, that noble general dear old Charlie Napier, any payment for excess of luggage, but contenting himself with a towel, toothbrush, hair-comb, piece of brown windsor, and a hand punka. I am not so ambitious on my Persian Railway (guaranteed and limited), I only propose to travel at the gentle speed of 15 miles per hour, on a modest 3 ft. 6 in. gauge line, with, as that distinguished scientific officer, General Richard Strachey, R.E., proposes for the Indian State Railways, "station buildings as simple as possible." On such a line as I propose, and intend carrying out, guns, gun-carriages, munition wagons, and other materials of war, can be placed upon properly constructed platform trucks, with the proper complement of men, and transported when restless Governments urge their populations to believe the carriage of such destructive missiles is more profitable than Manchester goods, which would be exchanged for the produce of their fields. This line, I am informed by officials in the Persian Gulf, could easily be constructed, and "would pay a good interest upon the capital if not made too expensively." Every mail from India brings news of the greater necessity for placing our house in order, and more strongly protecting our frontier gates, but when all is secure inside the house, it is necessary to be able to take a look at your annoyers by taking them also in the rear, and that can be done effectually in reference to India if my Persian Railway is constructed.

Your most obliged Servant,
HARDY WELLS.

London, October 16, 1871.

ENGINEERS IN INDIA.

TO THE EDITOR OF ENGINEERING.

SIR,—In some of the late numbers of your newspaper, which have reached us, I have observed a few letters and articles on "Engineers in India," showing, with reference to the new college just opened at Cooper's Hill, the prospects which students entering that college have before them on arrival in this country. All that has been written generally in regard to pension and furlough is true; but the annexed comparative statement of the leave rules of the three great services of India and of the allowances when on furlough of military and civil officers of the Public Works Department will show more clearly the very great differences which exist to the disparagement of the engineering profession.

From the annexed it will be seen that a first-class civil chief engineer draws a less allowance by 254*l.* per annum when on furlough than a first grade military executive engineer, an officer five grades below him in the service, and the discrepancies throughout are equally glaring.

It is proverbial how little Indian matters are known at home, as many who have come to this country have found to their cost. How, after entering into a "covenant" with the Secretary of State in England, they have found themselves classed here with the native uncovenanted service down to men whose pay is only perhaps 100*l.* a year, with their rules and standing, i.e., with the leave and pension rules and position of the people of the country.

Comparison of the Leave Rules of Civil and Military Services, with those of Civil Engineers in the P. W. D.

Civil Service.	Military Officers in Civil employ in Public Works Department.	Civil Engineers in the Public Works Department.
(1.) The maximum period of furlough during whole service is limited to 6 years.	(1.) The maximum period of furlough during whole service is limited to 8 years.	(1.) The maximum period of furlough during whole service is limited to two years.
(2.) Subject to the above limit, 1 year's furlough is placed to the credit of each officer for every 4 years of actual service, but no furlough can be taken until the completion of 8 years' service.	(2.) Subject to above limit, an officer is eligible for 2 years furlough, on completion of 8 years actual service, and afterwards for 1 year after the completion of every 6 years from date of return from last leave.	(2.) Of the above, one year is allowed after the completion of 10 years' service, and the 2nd year on the completion of 18 years' service.
(3.) Furlough on medical certificate may be taken without reference to the amount at credit.	(3.) An officer not entitled to furlough may obtain leave on medical certificate, with English furlough pay.	(3.) Medical leave with allowance shall not exceed 3 years in whole period of service. It may be taken to Europe in two periods only, and must in no case exceed 2 years at one time.
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The civil engineers in India are now a large and important body of men, too large and too important to be represented at head-quarters by a stranger to their interests and a neutral one to their success; they never will be fairly dealt with, nor their services fully brought into use, until the head is one of themselves, who will feel for them and be proud of them, who will look upon himself as responsible for their work and for their rights; and if the department is really to be worked up to its power, the sooner Government has a civil chief the better.

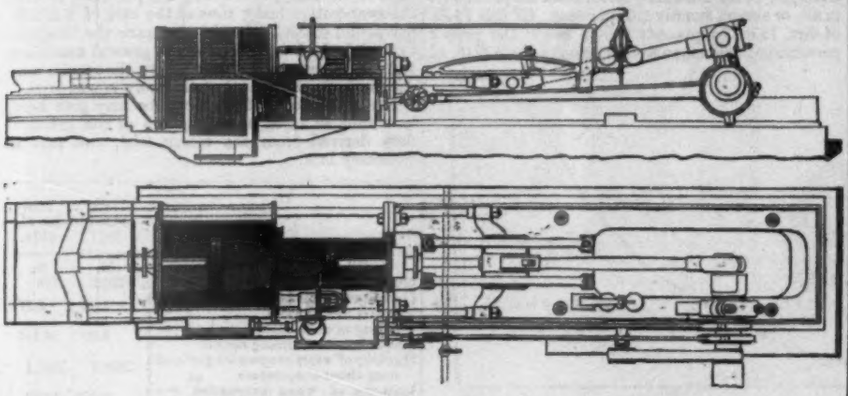
What father knowing these things will send his son to Cooper's Hill, and what aspirant to the Public Works Department of India will not rather enter it with a red coat, a sword, furlough, precedence, and rupees, than with a black coat, a theodolite, native rules, snubbing, and existence?

Yours obediently,
India, September, 1871. P. F. T.

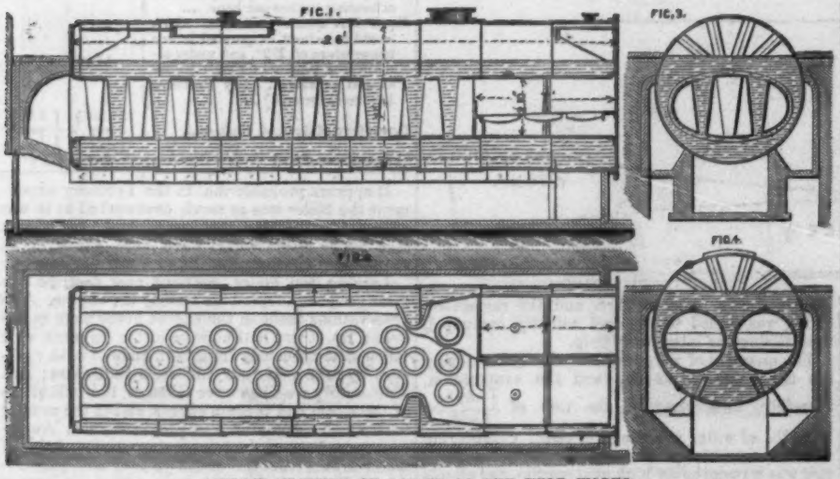
TUTICORIN LIGHTHOUSE.—Plans for a lighthouse at Tuticorin are being prepared. It is expected that the works will be commenced in a few weeks.

A STEAM ENGINE TRIAL.

It unfortunately happens that there are but exceedingly few records available of exhaustive and reliable trials of steam engines of various classes. Numbers of engine trials are made, it is true, but the instances in which such experiments are of sufficiently long duration and in which a sufficiently complete series of observations are made are very rare, and their results are of proportionate value. It is for this reason that we have much pleasure in laying before our readers an account of a very complete trial of a horizontal compound engine carried out three weeks ago at the Hele Works, Cullompton, Devon, a large paper mill belonging to Mr. C. R. Collins, to whom we are indebted for permission to make the results public. The



OUTLINE ELEVATION AND PLAN OF ENGINE AT THE HELE WORKS.



OUTLINE SECTIONS OF BOILER AT THE HELE WORKS.

engine on which the experiment was made was one constructed for Mr. Collins by Messrs. Bryan Donkin and Co., of Bermondsey, and it had been at work, running night and day with the exception of Sundays, since the 16th of December, 1870. The trial was made on the 11th ult., so that the engine had then been in use about ten months; but as it is employed in driving rag engines, it is run continuously each week from midnight on Sunday to midnight on Saturday without any stop whatever (except for ten minutes daily to oil and clean, or on account of accident to a belt in the mill, or similar cause) so that during the ten months it had run fully as many hours as most factory engines would have to do in two years. The high-pressure piston had been changed on the 17th of May last, but the low-pressure piston had not been changed since the engine was started, so that the engine was tested in ordinary working conditio., and the results were such as could be relied upon in regular practice. Before explaining, however, in detail the manner in which the trial was carried out, it may be desirable that we should give some further particulars of the engine and of the boiler by which it was supplied with steam.

The engine is, as we have already stated, of the horizontal compound condensing class, and is of the pattern* which has for time past been adopted by Messrs. Donkin and Co., and which is patented by Mr. B. W. Farey of their firm. As will be seen from the annexed sketch, the two cylinders are placed in a line with each other, the high-pressure cylinder being situated next the crank shaft. The low-pressure cylinder only is jacketted and the steam is led through this jacket on its way to the valve chest of the high-pressure cylinder, while the water arising from condensation is carried off by an efficient steam trap. The distribution of the steam is effected by ordinary slide valves, that of the high-pressure cylinder having an adjustable expansion valve at the back. The two main valves are driven by a single eccentric as shown in the sketch, the spindle for the low-pressure valve being a prolongation of that for the high-pressure cylinder, while a second eccentric drives the expansion valve as usual. The steam passages are all so arranged that the cylinders are completely drained, and ample clearance is provided—1 in. at each end in both cylinders—so that the engine may be run for a long period without readjustment of the connecting rod or crank shaft bearings—an important point in the case of engines which have to be kept constantly at work and which are not always under skilled supervision.

A feature worthy of notice also in the engine we are describing is the mode in which the pistons are prevented from dragging on the bottom of the cylinders. Referring to the sketch it will be seen that the piston rods pass out at opposite ends of the cylinders, that they are attached to crossheads, and that these crossheads are connected by side rods which pass along the sides of the cylinders as shown in the plan. These parts are so put together that the piston rods are directed upwards to just a sufficient extent to enable them to carry the pistons clear of the bottoms of the cylinders, the whole weight being thus borne by the crosshead slides which have ample surface. This mode of carrying the pistons is found to answer its purpose well and to prevent the cylinders from being worn oval, the pistons moving in the cylinders as freely as if the latter were in the vertical position.

The engine is provided with an ordinary injection condenser, and the injection water is drawn from an adjacent river, no cold water pump being used. Messrs. Donkin usually place the air pump of these engines beneath the crank and drive it by a rod coupled to the underside of the connecting rod close to the large end. In the case of the engine made for Mr. Collins, however, the air-pump has been placed on one side, and it is driven by a double crank on a shaft placed in a line with the crank shaft and having at its end a crank which is coupled to the main crank by a drag link. These details, however, have not been shown on the sketch, the object of the latter being merely to assist us in explaining the leading features of the engine. Lastly, we should state that the stroke of the engine is 3 ft., and that, the cylinders being carefully gauged, their diameters, when hot, were found to be 16$\frac{11}{16}$ in. and 30$\frac{7}{8}$ in. respectively.

The boiler by which the engine is supplied with steam is one constructed by Messrs. W. and J. Galloway and Sons, of Manchester, and is of their well known type, as shown by the annexed diagram. It is rated by the makers as a 50 horse power boiler, is 26 ft. long by 7 ft. in diameter and is made of $\frac{3}{4}$ in. plates double rivetted at the longitudinal seams. The two front flues are each 2 ft. 10 in. in diameter and 7 ft. long; they are made of $\frac{3}{4}$ in. plates with welded seams, and are strengthened by T-iron rings, while the back flue, which is of elliptical section, has a horizontal diameter of 5 ft. 8 in. and a vertical diameter of 3 ft. This back flue is traversed by twenty-seven Galloway tubes—each 10$\frac{1}{2}$ in. diameter inside at the top and 5$\frac{1}{2}$ in. at the bottom—disposed as shown, while it is also made with a pair of side "pockets" placed as seen in the plan, these "pockets" causing the mixture of the gases coming from the two front flues. The firebars of each grate are in three 2 ft. lengths, and the firegrate area is 33 square feet. The hot gases on escaping from the back flue are led along the two sides of the boiler and then back under the bottom of the latter to the chimney.

The total heating surface of the boiler is as follows:

	square feet.
Fireboxes	72
Oval flue	240
27 cone tubes and 2 pockets ...	144
Side flues	220
Bottom flue	72
	748

The boiler had been thoroughly cleaned out and the flues swept, prior to the trial on the 11th ult., and it had, in fact, only been lighted up about 21 hours when the trial commenced, so that the brickwork setting was scarcely thoroughly warmed through. This was slightly against it, as was also the fact that it was worked very much below its real power, so that the constant losses due to radiation, &c., went far to balance any advantage due to the slow combustion and the very moderate evaporation per square foot of heating surface. That this was the case we shall show presently by comparing the results obtained on the 11th ult. with those obtained during a previous trial when the rate of evaporation was nearly two and a half times as great. The boiler is fed by a small donkey pump, this pump being, during the experiment, supplied with steam from an adjacent boiler, so that its use should not affect the results obtained from the main engine. The boiler under trial is situated, we should state, at the end of a range of boilers of which the steam pipes are connected. To do away with any chance of leakage through the one connecting stop-valve, however, the adjacent boiler was kept at the same pressure as that under trial during the whole of the experiment, so that there should not be the slightest tendency to leak either way. The boiler, we should add, is carefully lagged, as is also the steam pipe which connects it with the engine.

These things being premised we may now proceed to explain the mode of conducting the experiments, which were carried out by Mr. C. R. Collins, Mr. Bryan Donkin, Mr. B. W. Farey, Mr. Bryan Donkin, junior, and the present writer; Mr. Charles J. Galloway being also present during the whole of the trial. The object of the trial—which commenced at 9.30 a.m. and lasted until 7.30 p.m., a continuous period of ten hours—was to ascertain

* A detailed and illustrated description of this class of engine appeared on page 4 of our ninth volume.

You may ask if I have any reason to believe in the necessity of this line. I have. After the Persian war was over in 1857, and the Commander-in-Chief, General John Jacob, returned disappointed, through peace being proclaimed, of his opportunity to add to his Indian renown, he entered upon the matter to me, explained the great mistake that was made in going to Bushire; that possession should have been kept of the rich populous districts through which my railway would go, and he said if the war had gone on it was his intention to have done me the honour of applying to Government for my services to survey and lay out the line gradually as the army advanced into the interior, and he said, some day the Government would find out they never ought to have left the country without receiving guarantees from Persia and Turkey that every one connected with the project should be protected, and he would have left a regiment of his own Sinde horse, recruited from the country people, to have acted as police in the country. With the Suez Canal open, and this line of mine made, an army could in less than a month be transported into the heart of Persia, and Russia be kept in check, and if at any time it be thought advisable a fleet of gunboats could be placed upon the Caspian Sea. If a repetition of the Persian troubles of 1856-57 should occur the first thing the English Government would have to do would be to send railway material to the point I propose to start from. Let us anticipate such troubles, and by anticipation prevent them, by sending locomotives and civil engineers, make roads and railroads before we consent to send English officers who have been applied for by the Shah of Persia to command his soldiers.

It may be thought, in my maturer age, I have lost some of the enthusiasm that was my characteristic for some years in India, when I try to put off the direct London and Calcutta Railroad, originated by Sir Macdonald Stephenson. It might be thought I am forgetful of the bird-nesting scenes of the Malay Archipelago, where I have seen the natives hanging in the air by what seemed threads, while they chiselled the rocks overhanging the ocean to get their prey; when I say that upon the promontories reaching out into the Persian Gulf and Arabian Sea Messrs. Low and Thomas, with a guarantee for forty millions, will find such a necessary means of cutting galleries on such rocks for a railway rather a weary, unconfortable, and disheartening duty, and I am afraid the result of "measuring up the work" would give a very unsatisfactory "progress report" to the shareholders. Let them, however, go on between "Trieste and Aleppo," who knows what may be done by able Englishmen with their hearts in the right place? All honour, I say, to the daily and scientific journals which allow the agitation and ventilation of these schemes, for they lead to the puffing locomotive taking the place of the deadly roaring cannon.

Messrs. Low and Thomas may have visions of travelling at the rate of "75 miles an hour," and driving the engine that is to draw the Governor-General of India, with a through ticket in his waistcoat-pocket, to the seat of his Government, despising, like his great forerunner, that noble general dear old Charlie Napier, any payment for excess of luggage, but contenting himself with a towel, toothbrush, hair-comb, piece of brown wiesbor, and a hand punka. I am not so ambitious on my Persian Railway (guaranteed and limited), I only propose to travel at the gentle speed of 15 miles per hour, on a modest 3 ft. 6 in. gauge line, with, as that distinguished scientific officer, General Richard Strachey, R.E., proposes for the Indian State Railways, "station buildings as simple as possible." On such a line as I propose, and intend carrying out, guns, gun-carriages, munition wagons, and other materials of war, can be placed upon properly constructed platform trucks, with the proper complement of men, and transported when restless Governments urge their populations to believe the carriage of such destructive missiles is more profitable than Manchester goods, which would be exchanged for the produce of their fields. This line, I am informed by officials in the Persian Gulf, could easily be constructed, and "would pay a good interest upon the capital if not made too expensively." Every mail from India brings news of the greater necessity for placing our house in order, and more strongly protecting our frontier gates, but when all is secure inside the house, it is necessary to be able to take a look at your annoyers by taking them also in the rear, and that can be done effectually in reference to India if my Persian Railway is constructed.

Your most obliged Servant,
HARDY WELLS.

London, October 16, 1871.

ENGINEERS IN INDIA.

TO THE EDITOR OF ENGINEERING.

SIR,—In some of the late numbers of your newspaper, which have reached us, I have observed a few letters and articles on "Engineers in India," showing, with reference to the new college just opened at Cooper's Hill, the prospects which students entering that college have before them on arrival in this country. All that has been written generally in regard to pension and furlough is true; but the annexed comparative statement of the leave rules of the three great services of India and of the allowances when on furlough of military and civil officers of the Public Works Department will show more clearly the very great differences which exist to the disparagement of the engineering profession.

From the annexed it will be seen that a first-class civil chief engineer draws a less allowance by 254*l.* per annum when on furlough than a first grade military executive engineer, an officer five grades below him in the service, and the discrepancies throughout are equally glaring.

It is proverbial how little Indian matters are known at home, as many who have come to this country have found to their cost. How, after entering into a "covenant" with the Secretary of State in England, they have found themselves classed here with the native uncovenanted service down to men whose pay is only perhaps 100*l.* a year, with their rules and standing, i.e., with the leave and pension rules and position of the people of the country.

Comparison of the Leave Rules of Civil and Military Services, with those of Civil Engineers in the P. W. D.

Civil Service.	Military Officers in Civil employ in Public Works Department.	Civil Engineers in the Public Works Department.
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I write this chiefly for the information of the parents of the new students at Cooper's Hill, and would point out to them that by sending their sons to that college for entering the Public Works Department of India, unless the leave and pension rules be somewhat assimilated to those of military men in the same department, they have gone the wrong way to work altogether. It has been shown in former letters to you, Mr. Editor, that staff corps men in the department are the best paid of all, i.e., the amateur engineers are paid far better than either the professional military or civil men. Now if your son show an unfortunate predilection for Indian engineering, do not wait till he is old enough to enter the new college at 150*l.* a year, but send him at 15 years of age to Sandhurst, which is considerably less expensive. Thence, say at 18, let him take or buy his commission in any line regiment about to go to India. He arrives at his station in six months at least, and then gets leave to study the language, passes the examination in another six months, and joins the Staff Corps, when his purchase money is returned to him. He now goes to Roorkee College (parents should know of this college, which produces engineers for the Public Works Department in six months), and enters the Public Works Department as an assistant engineer, it is true, but as a lieutenant with higher pay, a younger man, and at less cost than if he had gone to Cooper's Hill, with precedence undoubted, and with the satisfaction of knowing that his future increase of salary will not entirely depend on his professional abilities, but on his seniority promotion in his corps, notwithstanding the promises held out by the Under Secretary of State, Mr. Grant Duff, and the nonsense talked of having created a third great Indian service, on a par with the two already existing. The precedence list just out shows how Public Works officers are valued. In that list they have no rank at all below superintending engineers, first class, that is, men of probably 20 years' service, and getting 1900*l.* a year as pay; while in the education, finance, and even in the comparatively new telegraph department, men are ranked whose pay is not more than 600*l.* to 800*l.* a year, and who have not been three years in the country. The fact is the civil engineers have no one to fight their battles. How can it be expected that a Royal Engineer officer, or the Artillery officer—excellent man though he is—who is now at the head of this department, and who has for himself and his brother officers done all that can be desired, will trouble himself more than he can help about civil engineers, or that he will be very anxious to put them on a footing with himself and his corps.

The civil engineers in India are now a large and important body of men, too large and too important to be represented at head-quarters by a stranger to their interests and a neutral one to their success; they never will be fairly dealt with, nor their services fully brought into use, until the head is one of themselves, who will feel for them and be proud of them, who will look upon himself as responsible for their work and for their rights; and if the department is really to be worked up to its power, the sooner Government has a civil chief the better.

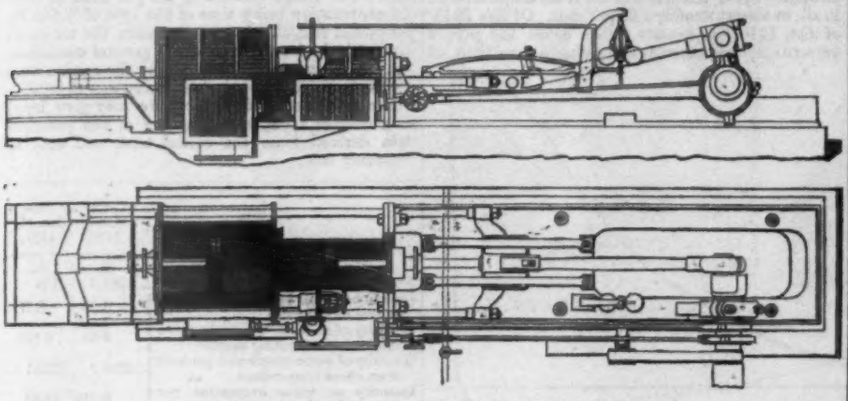
What father knowing these things will send his son to Cooper's Hill, and what aspirant to the Public Works Department of India will not rather enter it with a red coat, a sword, furlough, precedence, and rupees, than with a black coat, a theodolite, native rules, snubbing, and existence?

Yours obediently,
India, September, 1871. P. F. T.

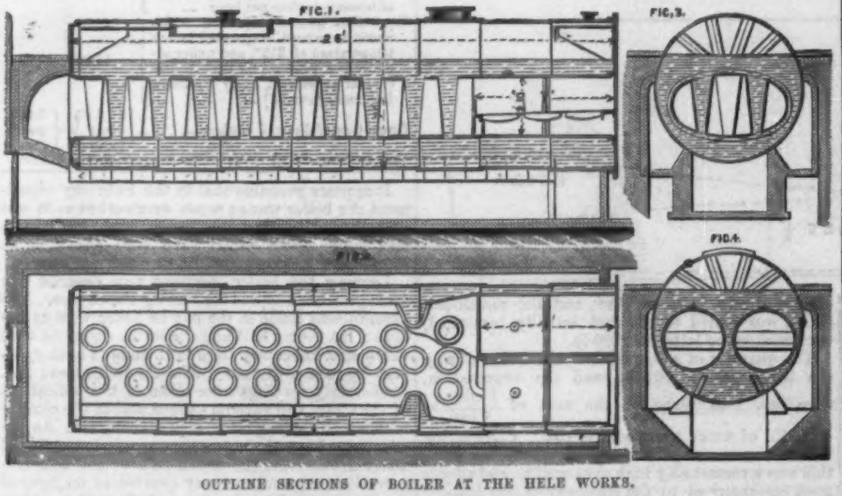
TUSCORIN LIGHTHOUSE.—Plans for a lighthouse at Tuticorin are being prepared. It is expected that the works will be commenced in a few weeks.

A STEAM ENGINE TRIAL.

It unfortunately happens that there are but exceedingly few records available of exhaustive and reliable trials of steam engines of various classes. Numbers of engine trials are made, it is true, but the instances in which such experiments are of sufficiently long duration and in which a sufficiently complete series of observations are made are very rare, and their results are of proportionate value. It is for this reason that we have much pleasure in laying before our readers an account of a very complete trial of a horizontal compound engine carried out three weeks ago at the Hele Works, Cullompton, Devon, a large paper mill belonging to Mr. C. R. Collins, to whom we are indebted for permission to make the results public. The



OUTLINE ELEVATION AND PLAN OF ENGINE AT THE HELE WORKS.



OUTLINE SECTIONS OF BOILER AT THE HELE WORKS.

engine on which the experiment was made was one constructed for Mr. Collins by Messrs. Bryan Donkin and Co., of Bermondsey, and it had been at work, running night and day with the exception of Sundays, since the 16th of December, 1870. The trial was made on the 11th ult., so that the engine had then been in use about ten months; but as it is employed in driving rag engines, it is run continuously each week from midnight on Sunday to midnight on Saturday without any stop whatever (except for ten minutes daily to oil and clean, or on account of accident to a belt in the mill, or similar cause) so that during the ten months it had run fully as many hours as most factory engines would have to do in two years. The high-pressure piston had been changed on the 17th of May last, but the low-pressure piston had not been changed since the engine was started, so that the engine was tested in ordinary working condition, and the results were such as could be relied upon in regular practice. Before explaining, however, in detail the manner in which the trial was carried out, it may be desirable that we should give some further particulars of the engine and of the boiler by which it was supplied with steam.

The engine is, as we have already stated, of the horizontal compound condensing class, and is of the pattern* which has for time past been adopted by Messrs. Donkin and Co., and which is patented by Mr. B. W. Farey of their firm. As will be seen from the annexed sketch, the two cylinders are placed in a line with each other, the high-pressure cylinder being situated next the crank shaft. The low-pressure cylinder only is jacketted and the steam is led through this jacket on its way to the valve chest of the high-pressure cylinder, while the water arising from condensation is carried off by an efficient steam trap. The distribution of the steam is effected by ordinary slide valves, that of the high-pressure cylinder having an adjustable expansion valve at the back. The two main valves are driven by a single eccentric as shown in the sketch, the spindle for the low-pressure valve being a prolongation of that for the high-pressure cylinder, while a second eccentric drives the expansion valve as usual. The steam passages are all so arranged that the cylinders are completely drained, and ample clearance is provided—1 in. at each end in both cylinders—so that the engine may be run for a long period without readjustment of the connecting rod or crank shaft bearings—an important point in the case of engines which have to be kept constantly at work and which are not always under skilled supervision.

A feature worthy of notice also in the engine we are describing is the mode in which the pistons are prevented from dragging on the bottom of the cylinders. Referring to the sketch it will be seen that the piston rods pass out at opposite ends of the cylinders, that they are attached to crossheads, and that these crossheads are connected by side rods which pass along the sides of the cylinders as shown in the plan. These parts are so put together that the piston rods are directed upwards to just a sufficient extent to enable them to carry the pistons clear of the bottoms of the cylinders, the whole weight being thus borne by the crosshead slides which have ample surface. This mode of carrying the pistons is found to answer its purpose well and to prevent the cylinders from being worn oval, the pistons moving in the cylinders as freely as if the latter were in the vertical position.

The engine is provided with an ordinary injection condenser, and the injection water is drawn from an adjacent river, no cold water pump being used. Messrs. Donkin usually place the air pump of these engines beneath the crank and drive it by a rod coupled to the underside of the connecting rod close to the large end. In the case of the engine made for Mr. Collins, however, the air-pump has been placed on one side, and it is driven by a double crank on a shaft placed in a line with the crank shaft and having at its end a crank which is coupled to the main crank by a drag link. These details, however, have not been shown on the sketch, the object of the latter being merely to assist us in explaining the leading features of the engine. Lastly, we should state that the stroke of the engine is 3 ft., and that, the cylinders being carefully gauged, their diameters, when hot, were found to be $16\frac{11}{16}$ in. and $30\frac{5}{16}$ in. respectively.

The boiler by which the engine is supplied with steam is one constructed by Messrs. W. and J. Galloway and Sons, of Manchester, and is of their well known type, as shown by the annexed diagram. It is rated by the makers as a 50 horse power boiler, is 26 ft. long by 7 ft. in diameter and is made of $\frac{7}{8}$ in. plates double rivetted at the longitudinal seams. The two front flues are each 2 ft. 10 in. in diameter and 7 ft. long; they are made of $\frac{7}{16}$ in. plates with welded seams, and are strengthened by T-iron rings, while the back flue, which is of elliptical section, has a horizontal diameter of 5 ft. 8 in. and a vertical diameter of 3 ft. This back flue is traversed by twenty-seven Galloway tubes—each $10\frac{1}{2}$ in. diameter inside at the top and $5\frac{1}{2}$ in. at the bottom—disposed as shown, while it is also made with a pair of side "pockets" placed as seen in the plan, these "pockets" causing the mixture of the gases coming from the two front flues. The firebars of each grate are in three 2 ft. lengths, and the firegrate area is 33 square feet. The hot gases on escaping from the back flue are led along the two sides of the boiler and then back under the bottom of the latter to the chimney.

The total heating surface of the boiler is as follows:

	square feet.
Fireboxes	72
Oval flue	240
27 cone tubes and 2 pockets ...	144
Side flues	220
Bottom flue	72
	748

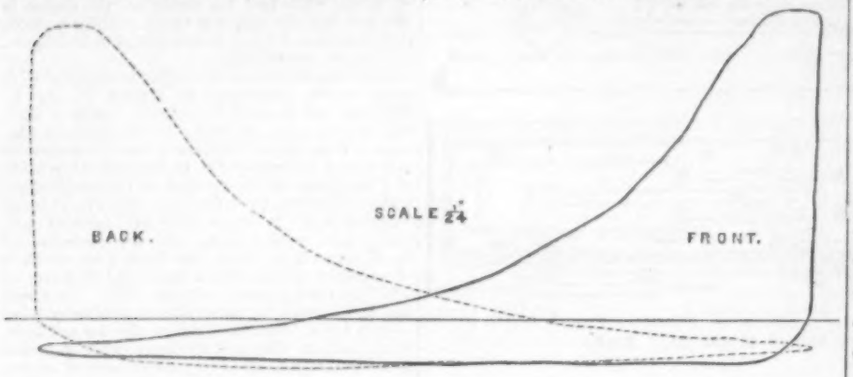
The boiler had been thoroughly cleaned out and the flues swept, prior to the trial on the 11th ult., and it had, in fact, only been lighted up about 21 hours when the trial commenced, so that the brickwork setting was scarcely thoroughly warmed through. This was slightly against it, as was also the fact that it was worked very much below its real power, so that the constant losses due to radiation, &c., went far to balance any advantage due to the slow combustion and the very moderate evaporation per square foot of heating surface. That this was the case we shall show presently by comparing the results obtained on the 11th ult. with those obtained during a previous trial when the rate of evaporation was nearly two and a half times as great. The boiler is fed by a small donkey pump, this pump being, during the experiment, supplied with steam from an adjacent boiler, so that its use should not affect the results obtained from the main engine. The boiler under trial is situated, we should state, at the end of a range of boilers of which the steam pipes are connected. To do away with any chance of leakage through the one connecting stop-valve, however, the adjacent boiler was kept at the same pressure as that under trial during the whole of the experiment, so that there should not be the slightest tendency to leak either way. The boiler, we should add, is carefully lagged, as is also the steam pipe which connects it with the engine.

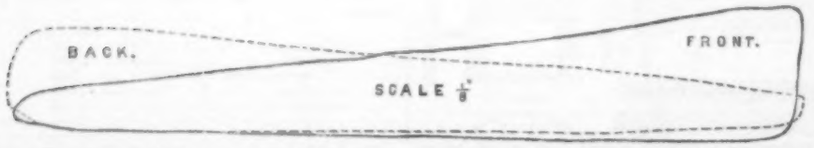
These things being premised we may now proceed to explain the mode of conducting the experiments, which were carried out by Mr. C. R. Collins, Mr. Bryan Donkin, Mr. B. W. Farey, Mr. Bryan Donkin, junior, and the present writer; Mr. Charles J. Galloway being also present during the whole of the trial. The object of the trial—which commenced at 9.30 a.m. and lasted until 7.30 p.m., a continuous period of ten hours—was to ascertain

* A detailed and illustrated description of this class of engine appeared on page 4 of our ninth volume.

the average horse power developed, the quantities of coal and water used, and further to make such other observations as would enable the whole of the heat furnished to the engine by the boiler to be satisfactorily accounted for. In describing the means adopted for procuring these data we will commence with the arrangements in the boiler house.

The boiler was fed from a small cast-iron tank situated by the side of it and to which the donkey pump already mentioned was fixed. This tank was fitted with a gauge showing the water level, and at the end of the experiment the water was brought to precisely the same level as that at which it stood at the commencement. The water used was filled into the tank by two cylindrical cans, each closed at the upper end with the exception of a small opening so that they could be accurately filled. The number of canfuls of water used was noted by two observers, whose records were found to agree, and the cans themselves were carefully weighed full and empty, and the weight of water used thus ascertained. The temperature of the feed water was also taken at intervals of about 20 minutes.





Before the experiment commenced all coals were cleared completely away from the front of the boiler, and into the space thus made the coals to be used on the trial were weighed under the supervision of Mr. Collins. The coals used were Powell's Duffryn, and were of excellent quality.

In commencing the experiment at 9.30 a.m., on a signal being given from the engine house, the water level in the boiler was marked on a scale fixed to the glass of the water-gauge, the pressure of steam was noted, and both fires were at once drawn with the exception of about a shovelful left in each furnace for relighting up. About 12 lb. of wood were then thrown in and the firing commenced with the weighed coal, the drawn fires being cleared away. When the fires were drawn the steam stood at 50 lb. per square inch, in five minutes it had fallen to 49 lb.; but in fifteen minutes it had risen again to 49½ lb., and in twenty-five minutes it was at 54 lb. During the day it was kept almost constantly at 53 lb., scarcely ever varying from this pressure more then a couple of pounds, and the mean of forty-nine observations taken at intervals of twelve minutes showed the pressure last mentioned to be the average throughout the experiment.

At 6.45 p.m., when the experiment was approaching a close, the pressure was 51½ lb., while at the end of the trial it was 49¾ lb. or almost exactly the same as it was at the beginning, while the water level was also precisely the same. On notice being given from the engine house that the trial was completed, both fires were drawn and the coal, cinders, &c., taken out and set on one side to cool, while at the same time the ashpits were cleaned out. When cool the materials drawn from the fires were passed over a sieve with ½ in. meshes and the clinkers picked out by hand, and the weights were then found to be as follows:

	cwt.	qr.	lb.
Cinders	2	0	15
Siftings	0	0	26
Clinkers	0	0	10
Dirt from ashpit	0	1	25
Total	2	3	20

The total amount of coal charged into the furnaces during the trial was 12 cwt., and the quantity consumed was thus 9 cwt. 0 qr. 8 lb. = 1016 lb. plus its proper proportion of the dirt. Of the siftings one-half was judged to be good fuel and the other half dirt, and the total quantity of dirt was thus 13 lb. siftings + 10 lb. clinkers + 53 lb. from ashpit = 76 lb. in all, or almost exactly 5.66 per cent. Of this 76 lb. of dirt, 12 lb. (a quantity rather below the proper percentage) was taken as belonging to the 239 lb. of cinders drawn from the fire, and the remainder, 64 lb., was added to the fuel actually consumed, thus raising the latter to 1080 lb.

The quantity of water fed into the boiler during the trial, was 11,691 lb., and the evaporation, therefore, took place at the rate of $\frac{11,691}{1,080} =$ 10.82 lb. of water per pound of coal. Considering that the mean temperature of the feed was 61¾°, this was a remarkably high evaporation, and affords good testimony as to the efficiency of the boiler.* We may add that the experiments made on the engine—and which we shall describe in due course—prove decisively that the quantity of water above mentioned was really evaporated, and that none of it passed away in priming. This is an important point, and it is one of many in favour of the system of engine testing adopted on the occasion of which we are speaking. It will be noted that during the trial we are describing, the boiler was worked far below its real power, the rate of evaporation being but 1.56 lb. per square foot of total heating surface per hour. There can be no doubt that this contributed to the economical result obtained; but at the same time, for reasons to which we have before referred, the advantage gained by this very slow rate of evaporation was not so great as might at first sight be supposed. In proof of this we may state that in February last year the same boiler was tested with an evaporation of 28,087 lb. of water in ten hours (a quantity nearly two and a half times as great as that evaporated during the trial we are now describing) and this weight was evaporated with a consumption of 2919 lb. of coals, containing 2.8 per cent. of dirt, the evaporation being thus at the rate of 9.622 lb. per pound of coal. In this instance the temperature of the feed was 75°, and the general conditions and arrangements for ascertaining the results were similar to those adopted at the more recent trial.

For convenience of reference we may give here, in a tabular form, a comparison of the principal data derived from the recent trial, and that in February last:

	Trial Feb. 8, 1871.	Trial Oct. 11, 1871.
	lb.	lb.
Quantity of coals burned per hour ...	291.9	108
Quantity of coals burned per hour per square foot of grate	8.85	3.27
Quantity of coals burned per hour per square foot of heating surface	0.30	0.144
Quantity of water evaporated per hour from above temperature ...	2808.7	1169.1
Quantity of water evaporated per pound of coal	9.622	10.82
Quantity of water evaporated from temperature of feed per square foot of heating surface per hour ...	3.75	1.56
Equivalent quantity of water which would have been evaporated from a temperature of 212°, and under atmospheric pressure for each pound of coal consumed. (By Professor Rankine's formula)	11.28	12.83
Percentage of dirt and clinkers	2.8 per c'nt.	5.66 per c'nt.
Temperature of feed	75°	61.75°

It appears probable that in the February experiment the boiler was as much overworked as it was underworked during the recent trial, and that a still better result would have been got with an evaporation of about 2000 lb. of water per hour.

Leaving the boiler, we must now describe the arrangements adopted for testing the engine. The observations made in the engine house were as follows: 1st. Every half hour indicator diagrams were taken simultaneously from both ends of both cylinders by means of four Richard's indicators; 2nd. Half-hourly readings were taken of the indications of the steam and vacuum gauges, and of the counter with which the engine was provided; 3rd. An account was kept of the temperature and quantity of water drawn from the steam jacket; and 4th. Observations were taken every quarter of an hour of the quantity and temperature of the water passing off from the condenser. The manner in which these latter important observations were made we must now describe. The water discharged by the air pump was led along a short iron trough fitted with partitions which extended nearly across it. The water on its way down the trough was caused to pass under and over and around the ends of these partitions, and it was thus thoroughly mingled, and the temperature rendered uniform throughout. After escaping the partitions it was discharged over a tumbling bay having a notch 6 in. wide carefully cut in a brass plate, while the head or height of water over the notch was taken by means of a hook gauge. The stem of the gauge had an index finger pointing to an accurately prepared scale* giving the rates of discharge per minute corresponding to the different heads, and the quantity of water passing off at any given time could thus be at

* It may be convenient for comparison with data derived from other experiments, if we reduce the results above stated to the equivalent evaporation from a temperature of 212°, and under the ordinary atmospheric pressure. To do this we may employ the convenient and well-known formula of Professor Rankine to determine what he has aptly termed the factor of evaporation. This formula is:

$$\text{Factor} = 1 + \frac{0.3\,(T_1 - 212°) + (212° - T_0)}{966},$$

in which T_1 = the temperature at which evaporation takes place, and T_0 = the initial temperature of the feed. In the case of the experiments above recorded, $T_1 = 310.2°$, that being the temperature of steam at a pressure of 53 lb. above the atmosphere, while $T_0 = 61\frac{3}{4}°$. The factor was thus:

$$1 + \frac{0.3(310.2 - 212) + (212 - 61.75)}{966} = 1 + \frac{179.71}{966} = 1.186.$$

Multiplying now the evaporation obtained during the experiments by this factor, we get $10.82 \times 1.186 = 12.83$ lb. as the equivalent evaporation which would have been obtained if the feed had been supplied at 212°, and the water boiled off under ordinary mean atmospheric pressure.

* It is only right that we should add here that the accuracy of the coefficient, namely, 0.62, used in calculating the discharge from the notch above mentioned had been carefully tested by Mr. B. W. Farey in previous instances by actually weighing the quantity discharged in a given time with various heads, and comparing these results with those obtained by calculation.

THE MONT CENIS TUNNEL; AIR COMPRESSING MACHINERY AT BARDONNECHE.

(*For Description, see Page* 283.)

FIG. 1.

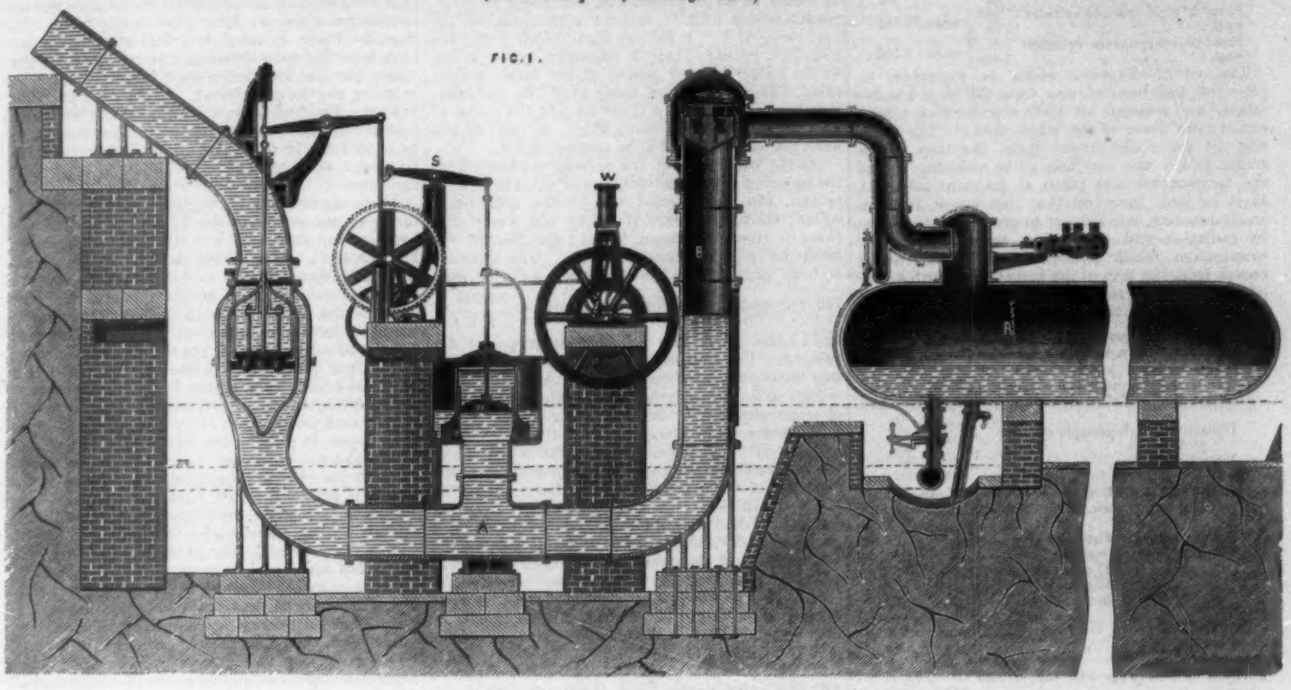


FIG. 2.

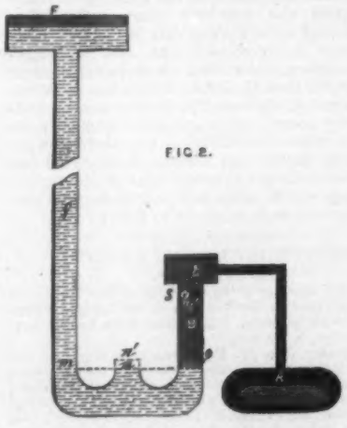
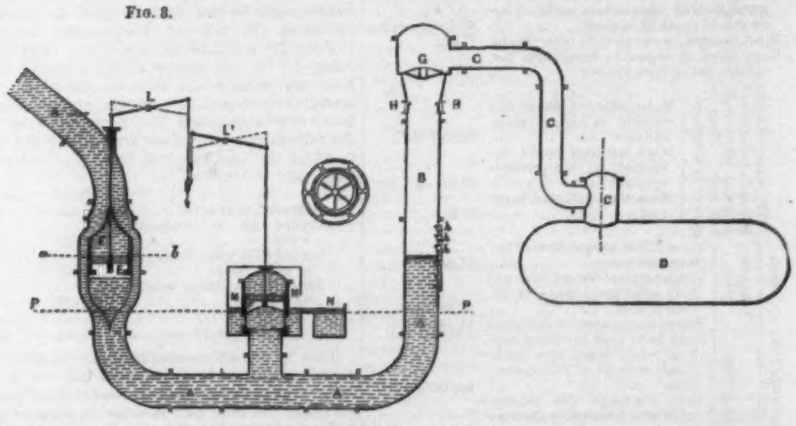


FIG. 3.



once read off while the temperature was taken by a delicate thermometer, on which the water fell in the tumbling bay. The temperature of the water used for injection was also noted at frequent intervals during the day, and thus the rise of temperature in passing through the condenser could be ascertained. This rise, expressed in degrees Fahr., multiplied by the discharge per minute in pounds, gave of course the number of pound-degrees of heat carried off per minute in the water from the condenser, and by dividing this quantity by the mean indicated horse power a number was obtained expressing the number of units of heat passed through the engine per horse power per minute.

This number or "constant" affords an excellent indication of the value of the engine as an economical power producer. The greater the quantity of heat which it is necessary to pass through the engine to develop a horse power, the higher of course is the number of pound-degrees of heat carried off in the condensing water, and the less the efficiency of the engine, and *vice versâ*. We have on former occasions* pointed out the delicacy of this system of testing engines—which has been developed by Mr. B. W. Farey and Mr. B. Donkin, jun.—and we have explained how, when the "constant" has been determined for any particular engine, it may be conveniently turned to account for the purpose of ascertaining approximately the power which that engine is developing at any given time. Thus if it has been ascertained that in the case of any given engine 350 pound-degrees of heat pass away per minute in the condensing water per horse power developed; then if on any particular occasion 35,000 units are passing away per minute, it will be at once known that the engine is developing 100 horse power, or if 28,000 pound-degrees are passing off, then the power developed will be 80 horse power. Of course determinations of power made in this way are to a certain extent approximate, as the constant varies somewhat at the different powers; but for moderate variations of power the alteration in the constant is very slight, and from the readiness with which the observations can be taken, if the overflow from the hot well is fitted with the necessary tumbling bay, the system is a very convenient one. Taken in connexion with indicator diagrams also, observations of the numbers of pound-degrees passing away in the water from the condenser show at once whether anything is the matter with the engine under trial, while they also enable comparisons to be instituted between engines of different types. It must be borne in mind, however, that the constants obtained from different engines are not directly comparable, or, in other words, do not strictly represent the comparative efficiencies of those engines unless the necessary corrections are made for the influence of different temperatures of the injection water, &c. These, however, are not matters into which we need enter here, and we must leave them, therefore, to be dealt with at some future opportunity, and return to the engine trial it is at present our special object to describe.

We have already stated that the engine on which the experiment was made, was employed in driving rag engines. Throughout the day every endeavour was made by charging the rag engines in succession, to keep the work to be done as constant as possible, and this was accomplished very successfully. The speed also was kept very regularly, the highest mean speed during any half-hour, as obtained from the observations of the counter, being 47.9 revolutions per minute, and the lowest 42.6 revolutions, while the mean speed for the ten hours was 46.51 revolutions. To ascertain the mean indicated power, the whole of the indicator diagrams were worked out, and the mean pressure thus obtained was used

* *Vide* pages 320 and 334 of our seventh, and page 28 of our eighth volumes.

in connexion with the mean speed observed by the counter. The mean effective pressures per square inch, deduced from the whole number of diagrams, were as follows:

	lb.		lb.
Front of high-pressure cylinder	17.408	mean	17.649
Back " " "	17.89		
Front of low-pressure cylinder	4.407	mean	4.106
Back " " "	3.806		

The set of diagrams which we reproduce on page 280, has been chosen from the large number taken, on account of their representing almost exactly the mean of the whole series. The quantity of water discharged from the trap of the steam jacket was ascertain ed by weighing it, and the temperature was taken at frequent intervals. It is evident, however, that this water, from its small quantity, was subject to great losses of heat by radiation and conduction, as well as by the evaporation which necessarily took place on its escape from the trap of the jacket. For convenience of reference we subjoin the results of the various observations, &c., in a tabular form:

Table showing the results of the trial of an engine at Mr. Collins's Hele Works, Cullompton, Devon, October 11, 1871.

Engine:

Class—Horizontal compound condensing (B. W. Farey's patent), made by Messrs. B. Donkin and Co., Bermondsey.

	ft.	in.
Diameter of high-pressure cylinder ...	1	4¼
" low " " ...	2	6⅞
Length of stroke...	3	0

Boiler:

Galloway's patent, made by Messrs W. and J. Galloway and Sons, of Manchester.

		sq. ft.
Heating surface:	Fireboxes	72
"	Oval flue	240
"	27 cone tubes and 2 pockets	144
"	Side flues	220
"	Bottom flue	72
	Total	748
Firegrate area		33

Results of Trial:

Duration of trial: from 9.30 a.m. to 7.30 p.m.=	10 hours.
Mean pressure of steam in boiler house—average of 49 observations made at intervals of about 12 minutes	53 lb. per sq. in.
Mean vacuum; average of 21 observations	27¼ in.
Mean speed of engine in revolutions per minute, taken from counter	46.51
I.H.P. taken with four Richard's indicators: 4 diagrams taken every half hour. Mean results of 64 diagrams. Mean indicated power developed in high-pressure cylinder	32.03 I.HP.
Mean indicated power developed in low-pressure cylinder	24.85 "
Mean total indicated horse power	56.88 "
Observations of water from condenser. Temperatures. Mean initial temperature of injection water	51.66°
Temperature of water discharged from condenser; mean of 38 observations	83.32°
Rise of temperature in condenser	31.66°
Quantities. Mean head over tumbling bay 6 in. wide, taken by a hook gauge, average of 33 observations	2 7/16 in. bare
Mean discharge per minute calculated from above observations	606.5 lb.
Pound-degrees. Found-degrees of heat discharged from condenser per minute= 606.5×31.66 ... ... =	19,202
Pound-degrees per horse power per minute = 19 202 / 56.88 = ...	337.6
Water from trap of steam jacket. Total quantity discharged during ten hours	1020 lb.
Quantity discharged per hour ...	102 "
" " minute ...	1.7 "
Temperature	174°
Feed-water. Initial temperature; mean of 28 observations	61.75°
Quantity evaporated during ten hours =108 cans, weighing each 108¼ pounds, = ...	11691 lb.
Quantity evaporated per hour ...	1169.1 "
" " minute ...	19.48 "
" " indicated horse power per hour	20.55
Quantity evaporated per pound of coal consumed	10.82
Coal. Description: Powell's Duffryn.	
Quantity consumed during ten hours	1060 lb.
" per square feet of firegrate per hour	3.27 "
Quantity consumed per indicated horse power per hour	1.9 "
Percentage of dirt	5.66 per ct.
Average temperature of outer air	57°
" " in engine house	76°
" " " boiler "	63°

It will be interesting if we now attempt to strike a balance between the heat supplied to the engine from the boiler and that which is accounted for in the observations above recorded. The total heat of steam at 53 lb. pressure is, according to Regnault's tables, 1205.7°, and the temperature of the feed being 61.75°, it follows that 1205.7 — 61.75 = 1143.95°, or, say, 1144° is imparted by the boiler to the water for each pound of the latter evaporated. The evaporation being 1169.1 lb. per hour, it follows that 1169.1×1144°=1,337,450 units of heat per hour, equal to 22,290.8, or, say, 22,291 units per minute, have to be accounted for.

On the other side of the account we have, first, the quantity of heat actually converted into power; second, the heat carried off by the condensing water; third, that carried off by the water discharged from the steam jacket; and fourth, the losses by radiation, conduction, &c. The quantity of heat transformed into work is 1 unit for each 772 foot-pounds of work performed, or $\frac{33,000}{772}$ = 42.76 units per minute for each horse power developed. The quantity of heat disposed of in this way during the experiment was thus 42.76×56.88 =2432 units per minute. Next of the 19.48 pounds of steam supplied by the boiler per minute 1.7 lb. were condensed in the steam jacket, while the remaining 17.78 lb. passed through the cylinder, and thus eventually reached the condenser. Of the 606.5 lb. of water per minute discharged from the latter 606.5 — 17.78 = 588.72 lb. was injection water, and had actually been heated through a range of 31.66°, while 17.78 lb. resulted from the condensation of the steam, and has to be considered as being raised from the original temperature of the feed to that at which it is discharged from the condenser, or 83.32 − 61.75 = 21.57°. The quantity of heat accounted for in the condensing water is thus (588.72×31.66)+(17.78×21.57) = 18638.9 + 383.5 =19022.4 pound-degrees per minute. In the same way the water drawn from the steam trap of the jacket has to be taken as heated from the initial temperature of the feed to that at which it is collected, its rise of temperature being thus 174 − 61.75° = 112.25, or, say, 112°. The quantity being 1.7 lb. per minute, 112×1.7=190 units of heat per minute are thus accounted for. Summarising these several amounts, and obtaining the losses due to radiation, &c., by subtraction, we get the following approximate account of the manner in which the heat supplied from the boiler is disposed of:

	Units.		Per Cent.
Converted into work... ...	2,432	=	10.9
Carried off in condensing water	19,022	=	85.3
Carried off in water coming out of steam jacket	190	=	0.8
Losses by radiation, conduction, &c.	647	=	3.0
Total per minute ...	22,291	=	100.0

This mode of comparing the results, affords certain evidence that the water got rid of in the boiler was really evaporated, and did not pass off in priming. In fact, had it done so, instead of there being a certain quantity of heat available to account for losses by radiation, &c., there would have been a deficit. The experiments were throughout carried out with the greatest possible care, and every endeavour was made to obtain a thoroughly reliable result; and the rough balance above struck between the heat supplied by the boiler and that accounted for, is, we believe, as accurate as it is possible to make it from the data derived from a trial conducted on a system applicable in general practice. We may mention here, however, that Mr. B. W. Farey and Mr. B. Donkin, junior, have employed, in a number of experiments on an engine at their own works, an apparatus designed by them, which enables the temperature and quantity of the water flowing from the condenser to be registered automatically and continuously by means of photography. This apparatus (which was illustrated and fully described on page 58 of our sixth volume), of course enables the number of units of heat passing from the condenser to be ascertained with greater accuracy than is possible by a series of individual observations, however frequent they may be. The error resulting from the latter mode of observation, however, is exceedingly small if the observer uses proper care, and it is amply accurate for all practical purposes.

Of the general performance of the engine and boiler tested at the Hele Works, it is unnecessary that we should say much, as the figures we have given speak for themselves. The results are, however, additional proofs of the advantages which are to be derived from the employment in mills of high class engines for furnishing the motive power, advantages which we have persistently urged. It must be borne in mind, too, that the results we have recorded were obtained with cold feed for the boiler, the cold feed being used for convenience in carrying out the experiment. In ordinary practice, however, the feed is drawn from the hot well, and passed through an economiser, which causes it to be heated nearly to boiling point before it enters the boiler, the result, of course, being a still greater economy.

There are numbers of engines now in use in factories consuming quantities of coal and water per horse power two and a half times as great as Mr. Collins's engine, and which are yet considered by their owners to be excellent examples of steam machinery. If such an engine was now in use at the Hele Works in the place of that of which we have been speaking, there would be used instead of an average of 108 lb. of coal per hour, 270 lb. per hour, or 3888 lb.=say, 34.7 cwt. per day of 24 hours. Taking the days actually at work as but 300 per annum, we should thus have 520 tons of coal per year saved by using a really high-class engine in place of one burning some 4½ lb. per indicated horse power per hour. Inasmuch as coal costs at the Hele Works nearly 1*l.* per ton by the time it is put on the fire, this is a very handsome annual saving, while, in addition, there is the reduction in the amount of boiler power required, and in the wear and tear of boilers, firebars, &c. Much has been said in some quarters respecting the cost of maintenance of high-class engines, and it has been urged that the saving which such engines effect in the fuel account is swallowed up in other ways. Now no greater error than this could be made. There is no necessity whatever that a high-class engine should be a complex one, and all who have had experience in the working of really well-designed and well-built compound engines will agree with us in stating that the cost of their maintenance is no greater than that of single-cylinder engines, while they can be run in a worse state of repair than the latter, with a less reduction of economy. Altogether Mr. Collins has, we consider, every reason to congratulate himself upon his choice, while the thanks of the profession are undoubtedly due to him for the facilities he has afforded for making a thorough trial of his engine, an example which many mill and factory owners would find it to their interests to follow.

INSTITUTION OF MECHANICAL ENGINEERS.

The general meeting of the members of this Institution was held on Thursday, October 26th, in the Lecture Theatre of the Midland Institute, Birmingham, John Ramsbottom, Esq., President, in the chair.

The Secretary (Mr. W. P. Marshall) having read the minutes of the previous meeting, several new members were elected, and the officers of the Institution were nominated by the meeting for the next annual election. Two papers were then read, one entitled a "Description of Miller's Cast Iron Steam Boiler," by Mr. John Laybourne, of Newport, Monmouthshire, and the other "On Steam Pressure Gauges," by Mr. Ernest Spon, of London, communicated by Mr. Charles Cochrane. Of the former paper we publish an abstract in the present number; the other we must defer until next week.

An adjourned discussion followed upon a paper read at a previous meeting, "On the principal constructions of Breech-loading Mechanisms for Small Arms, and their relative mechanical advantages." The special features of the Henry and the Soper rifle were pointed out by their respective inventors; and specimens were exhibited of these and numerous other breech-loading rifles, in illustration of the descriptions given in the paper. It was remarked that the particular construction of breech mechanism in the Martini rifle, which had at present been selected for the national weapon, was open to serious objection from a mechanical point of view, more especially in the substitution of a spiral main spring with direct action and short range, in place of the ordinary flat main spring acting with a variable leverage, the latter having been proved, by long practical experience, to be completely successful for the purpose. By the use of the spiral spring, the pressure upon the trigger nose at full cock is so greatly increased as to necessitate the addition of an exceptionally delicate contrivance for facilitating the pull-off in firing, and a consequent liability to irregularity in resistance is entailed; but the whole of this objectionable complication is obviated by reverting to the ordinary flat main spring, and an easy and uniform pull of the trigger is obtained. The meeting then terminated.

Cleveland Institution of Engineers.—Mr. Angus Macpherson, of 65, Pierson-street, North Ormesby, Middlesbrough, has been appointed as the new secretary of this society.

THE MONT CENIS TUNNEL.*

It has been mentioned already that the motive power used for the perforating machinery was air, the compression of which took place at some distance from the mouth of the tunnel, and that the compressing agent used was water. The compressors, which have been established at Bardonnèche, and were at first used, may be termed water column compressors.

The drawing on page 281 represents a complete vertical section of one of these compressors. Below is a theoretical diagram of the same, which I shall use to describe the action of this machinery.

For want of space the reservoir of water from which the compressing column, A, descends has been omitted in the section. It has been represented only on the diagram Fig. 2, where the vertical height of the fall through the inclined tube mentioned above, is represented by *f*, and the reservoir, the level of which is permanent, is marked E.

Referring now to the diagram† Fig. 3, A, is the compressing column, B the chamber of compression, C, C, C, the tubes for conducting the compressed air to D, the recipient for the same, E, E, are feeding valves, and F, discharging valves, G, the compressed air valve, H, H, H, the inlet air valves, *h*, *h*, *h*, are acceleration valves, L, the motive lever of the feeding valve, L', the motive lever of the discharging valve, M, M, the recipient of discharge, N, the canal of escapement, P, P, the regulating plane.

The supply valve, E, moves vertically. On the spot where it is placed, the compressing column takes an annular form, and the compressing agent, instead of moving along the axis of the column, and remaining cylindrical, is transformed into an annular vein, which runs along the outer side of the valve, E, and becomes cylindrical again below this valve. The section of the annular vein was calculated to be equal to the section of the cylindrical column of compression, so as to leave the section of the compressing column constant throughout its height.

In the diagram the valve, E, is supposed to be open, and the compressing column acts uninterruptedly on the air contained in the chamber, B.

Now, let us suppose that the valve, E, should be raised, and should close the annular space, all that part of the compressing column which is placed above the valve, E, will be suspended, and will cease to act on the part below, during the whole of the time that the valve, E, closes the annular space, and cuts off the column above, and hence the object of the valve, E, E, is to admit and to suspend the action of the compressing column. Leaving the valve, E, E, closed, we will examine the valve, F. This valve is also cylindrical, and moves vertically, opening when it rises, the lateral orifices of the recipient of discharge, and closing them in its descent. Raising the valve, F, all that part of the compressing column, which is inferior to E, is put, as well as the chamber, B, in communication with the atmosphere, and hence the water in M, M, and in B, will take naturally the level, P, P, determined by the level of the water in the canal of escapement, N, and in the recipient, M, M. All the part, B (chamber of compression), will then be full of atmospheric air down to the level, P, P, and the portions of the compressing column contained in the syphon under the valve, E, and in the annular portion will not be submitted to any pressure except the ordinary pressure of the atmosphere.

The valve, E, remains closed during the time that the valve, F, makes its double stroke and *vice versâ*. If while E is open F were also opened, it is evident that the water would escape with great impetus through the lateral orifice, M, M.

The valve, G, placed at the top of the compression chamber, A, by rising allows the air, after it has been compressed, to escape from B into the recipient, D, and closing again it prevents the flowing back of the same. The valves, H H, by opening from outside inwards, give access to the atmospheric air into the chamber, B, when the water, after having performed the compression, escapes through F.

The use of the valves, *h h h*, &c., will be explained hereafter, for the present we assume that they are closed. It is easy to understand the action of the compressor. Let us suppose the valves E and F both closed, and the level of the water to be at P P in the chamber B; let this chamber, B, be full of atmospheric air, and let the valves, H H, be supposed shut.

Now, allow the valve, E, to fall; the compressing column, A A A A, will immediately enter into motion; it will rise in B, and will compress the air contained in this chamber; the air in B will be compressed until it has acquired a sufficient degree of force to lift up G, and then the same compressed air will enter the recipient, D, the water rising until it touches G, where it will have lost all its velocity; the valve, G, will then be pressed from below, only by the static pressure of the compressing column, whereas from above it sustains the pressure of the air which has been driven into D, equivalent in this case to double the static pressure of the column, A A A.

At this moment all the compressing column up to the valve, G, is at rest. Let us then shut off, by lifting E, all that portion of the compressing column which is above E, and intercepts its action on the portion below; let us open the valve, F, and the water contained in B is driven out into M M, and will flow into the canal, N; the valve, H H, will open under the pressure of the atmosphere (vacuum having been formed in B), and the atmospheric air will enter into B, and will drive down the water to P P. When this level shall be reached, the whole system will be again at rest, and ready to commence a second "pulsation," and to that effect let F be closed and E be opened, and the same evolution which has been described will be repeated.

The play of the valves F and E is regulated by the engine, W, (Fig. 1.) which governs S, on which specially formed eccentrics are fixed, which produce the vertical movement of the valve at the necessary moment.

The result obtained with one pulsation is, as we have seen, the compression and the imprisonment in D of all the air at atmospheric pressure contained in B from the level, P P, up to the valve, G (See diagram). This result has been obtained through the action of a column of water of fixed height, determined section, and form, which, starting from the state of rest, flows with variable velocity through a definite space, at the limit of which the column of water loses all its velocity, and passes again into the state of rest, after having given over to the volume of the air it has compressed all the dynamic effort which has been consumed between the initial and final instant of the pulsation.

Up to the present it has been supposed that the compressing column, starting from the level, P P, in order to rise in the chamber, B, commences immediately to compress the air therein contained; and this hypothesis gives the normal state of the work of the machine, and from it those conditions are derived to which the compressor must answer to develop to the greatest possible industrial effect.

If a compressor were established, with a chamber, B, of a height corresponding to a compressing column likewise determined, the air would not be compressed to a higher state of tension than the one which would correspond to these data, and this circumstance would be inconvenient; however, the limits of the action of the compressor can greatly be extended, and to such a degree that the amount of compression should not depend on the height of the compressing column.

I shall describe the process which has been adopted to obtain this result in my next article.

FRANCIS KOSSUTH, C.E.,
Royal Commissioner for Railways in Italy.

* Continued from page 241, of the present volume.
† See Report of the Technical Directors, 1863.

STEAM ENGINE COEFFICIENTS — ERRATA. — In Mr. Schönheyder's letter, on page 269 of our last number, third column, third line from the top, for "it is no less than," read "it is much less than." At the upper right-hand corner of the diagram, also, accompanying the letter, for "*e*," read "*l*."

DOG-BOXES IN INDIA.—In March last a dog, the property of a gentleman living in the Punjab, was sent out from England, and landed in Bombay, and there it is still. The fact is the dog is a large one, and the traffic manager of the G. I. P. declares that he is too big to get into a dog-box, suggesting, further, that the owner of the dog should have a horse-box for him! Now, a horse-box from Bombay to Lahore is a matter of 250 rupees, rather more, in fact, than the cost of the dog's passage from England to Bombay. What, if we may ask, is the meaning of a "dog-box" on the G. I. P.? Does it mean a receptacle for cats? A "horse-box," according to the traffic manager, means a receptacle for dogs, what, then, can a dog-box mean? Meanwhile the animal which was too much for the Company is at Bombay, and has been there for four months.—*Indian Daily News.*

NOTES FROM PARIS.

PARIS, Oct. 30, 1871.

INDUSTRIAL WORKS ON THE RHÔNE.

We have already mentioned the project for utilising the fall of water in the Rhône, near the place called the Perte du Rhône, at Bellegrande. A recently published pamphlet gives us some new particulars of this important undertaking.

The Rhône is able to furnish at the point chosen, a fall of 63 ft. 4 in. which, utilising one-third of the minimum of the water, which is 6355 cube feet per second, will give an available force of 10,000 horse power. The promoters have acquired the concession of the use of this force, as well as of all they may wish to utilise on the Valserine, a river that falls into the Rhône at Bellegrande. They have also acquired considerable property situated in the neighbourhood of the fall, besides the mills and houses built on these grounds. The enterprise has been developed by M. Colladon, of Geneva, a well-known engineer.

The promoters state that in times of flood the motive power of the Rhône is little affected, that the *régime* of the river is almost invariable on account of the proximity of the lake of Geneva, which serves as an immense regulating reservoir, and that the highest floods produce neither inundation nor dangerous risings. The water of the Rhône at the outfall into the lake is remarkably pure, and is available for almost all industrial purposes; it is already employed at Lyons for dyeing, and in most chemical works.

The conceded lands form for the largest proportion of their extent, vast plateaux surrounded by the motive power; they will be available for the erection of manufactories and works of all kinds. They are situated between two great cities, Lyons and Geneva, the Paris-Lyons and Mediterranean and the Mont Cenis Railways traverse them. All parts of the plateaux can easily be put in communication with the railways by junctions. The ground is underlaid with solid rock suitable for foundations, and materials for construction are found in abundance on the site. A part of the acquired land is situated in Gex, which, by a treaty with Switzerland, is beyond the territorial line of France.

The coal basins of Saint-Etienne, of Rive-de-Gier, and of Blanzy are near to Bellegrande. Coal sells at 21 francs per ton. The numerous foundries and rolling mills of the department of the Loire, of the Rhône, the Jura, of Saône-et-Loire, and of Andrèché are not distant, and can furnish wrought and cast iron at low prices.

Hydraulic lime is abundant and cheap; bricks, tiles, cement, and also the acid employed in many chemical operations, are found in good condition. The position of Bellegrande is for the most part favourable for transport; it is a central point for Italy, Lyons, Marseilles, the centre of France, the Loire, Paris, &c. The railways passing Bellegrande touch the Saône and the Rhône, which is open for light traffic to Seyssel, and thence is navigable to the sea.

The promoters point out, also, that the conditions of labour are most advantageous. Within a radius of three miles from the Bellegrande Railway station, there are divided amongst fifteen villages, a population of 9000 inhabitants, who are hardworking and moderate. Taking a more extended area, we find in the department of Ain many industries already established, notably silk spinning, wool carding, and utilising silk waste, weaving cloth and silk goods, the manufacture of combs, &c., and the asphalte mines of Pyrimont-Seyssel.

The single arrondissement of Nantua contains 2700 workmen in the silk spinning and silk waste trades; the men are paid 2.50 francs, the women 1.50, and the children 0.75 to 1.10 francs per day. We could besides cite a number of industrial localities where hard labour is abundant and low priced, and Savoy contains a poor and industrious population disposed to emigration.

The promoters would construct near Bellegrande suitable houses with gardens, intended to receive the population which the new industries would draw together.

The feeding canal from the Rhône starts in the bend of the river a little above the Perte du Rhône. It would be pierced for some metres below the level of the lowest water, and would be prolonged by a tunnel passing below Gex for a length of about 1700 ft. This tunnel will end in the bed of the Valserine, in which there will be made a second canal flowing into the Rhône.

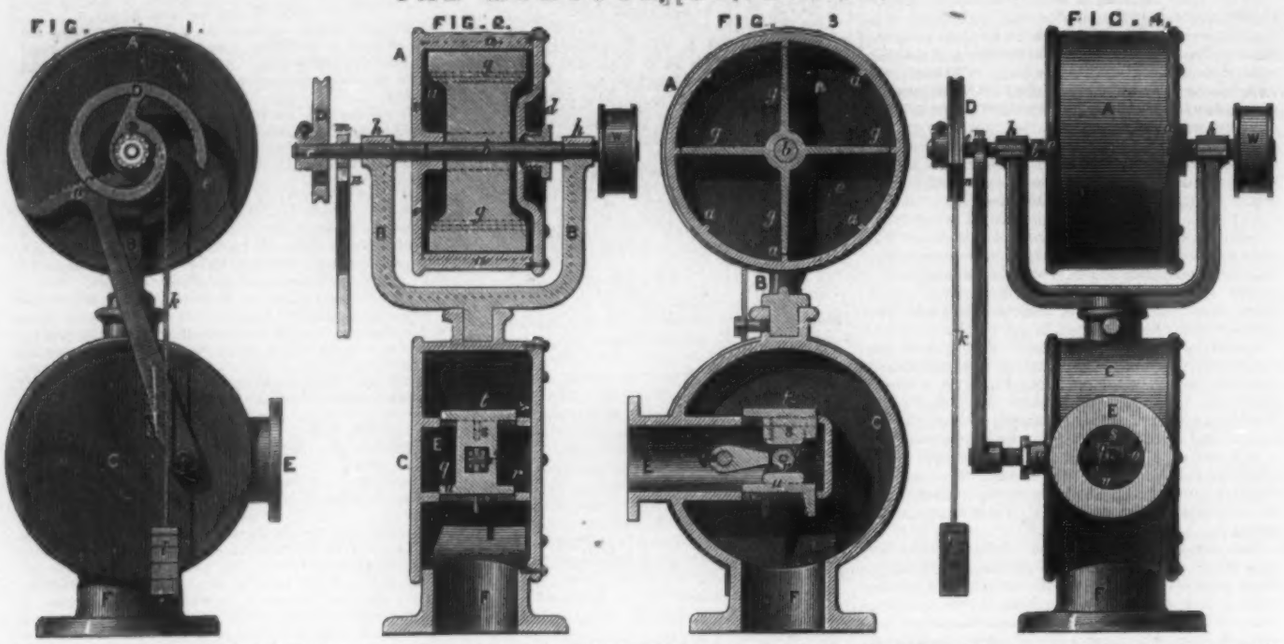
In the Valserine canal, there will be placed the turbine house, containing a number of motors sufficient for the force it will be desirable to concentrate on this point.

The works inaugurated on the 21st July, 1871, will be finished with a very short delay.

It will be seen after the foregoing notice, that the establishment of so large a power at Bellegrande, will give every opportunity of calling into this locality a number of various industries, which will apparently find there the principal elements of prosperity. But it is truly desirable that the promoters should not reckon too much on the vitality of the spirit of enterprise in France, nor that they should expect to realise the same success that similar undertakings have met with in America.

INDIAN METALLIFEROUS DEPOSITS.—Mr. Mark Fryar, mining engineer to the Indian Government, has visited the Tenasserim provinces in British Burmah to examine some metalliferous deposits.

THE HUNTOON GOVERNOR.



We have on several occasions noticed the Huntoon governor and modifications of it patented by Mr. S. B. Allen, of Massachusetts, U.S., and we now illustrate the latest improvement made in it, Fig. 1 of our engravings being a front elevation; Fig. 2 a vertical and longitudinal section; Fig. 3 a transverse section; and Fig. 4 a side view.

In these figures, A denotes a cylindrical drum provided on its inner periphery with a series of flanges or ribs, *a*, *a*, arranged at or about equal distances apart. This drum is mounted on, and so as to turn on, a shaft, *b*, there being another shaft, *c*, to which the drum is fixed. The shaft, *b*, extends into the drum from one head, *d*, the shaft, *c*, being extended from the other head, *e*, as shown. To the shaft, *b*, and within the drum, a series of paddle or flat wings, *g*, *g*, are fastened, each of these paddles being made to radiate from the shaft in manner shown in Fig. 3. The two shafts are supported in bearings, *h*, *h*, in a standard, B, erected on a valve case, C, as shown. On the shaft, *c*, there is fixed a volute scroll or fusee, D, having a chain or rope, *k*, fastened at one end to its periphery and extended partially around to a weight or series of weights, *l*. A small gear wheel or pinion, *m*, fixed on the shaft, *c*, engages with a toothed sector, *n*, fixed on a shaft, *o*, passing through the valve case, C, through a stuffing box, *p*, and thence into the induct, E. An arm, *q*, carrying a friction wheel, *r*, projects from that part of the shaft, *o*, which is within the induct, E, of the valve case and enters a slot or passage, r^1, made in the shank, *s*, that connects two valves, *t*, *u*. These valves are arranged as shown, with ports or openings, *v*, *v*, made in the opposite sides of the tubular induct, E, projected within the case, C, the said induct being closed at its inner end. An educt, F, leads out of the lower part of the case, C.

If now we suppose a driving belt from a pulley or drum on a shaft of a steam engine to run upon a pulley or wheel, *w*, fixed on the shaft, *b*, the series of paddles or floats, *g*, will be put in revolution within the case, A. Such case is filled with water or with a fluid which by the action of the paddles or floats will be put in revolution and thrown against the flanges or ribs, *a*, of the case, A, thereby causing the said case to revolve in the same direction. As a consequence the pinion, *m*, will be revolved so as to put the tooth sector, *n*, in movement, so as to turn the shaft, *o*, and thereby effect a movement of the valves or what may be termed the double balanced valve of the induct, E, of the valve case, C. The rotary movement of the case, A, will be resisted by the weight suspended from the scroll or fusee, D, which as it revolves will increase the leverage of the weight on the shaft of the case.

An arm projecting from the shaft, *c*, and provided with an adjustable weight is not so effective as the scroll or fusee with its line and weight, for with the former the effect of the weight is diminished as the arm moves out of a horizontal position, but with the fusee or scroll the effect or resistance of the weight constantly increases as its rope is wound up by the scroll or fusee. Thus it will be seen that with the scroll or fusee there is an element in action not incident to the arm and weight as ordinarily used, such element and the functions performed by it being specially useful or advantageous with the governor and other mechanism as described.

By having the valves operated by the arm, *q*, applied to their connexion, *s*, there will be no pressure on the valves such as would result were their stem extended through a stuffing box and out of the case, C. Consequently the compound valve becomes a "balanced valve" easily put in operation by the governor.

Applying the fusee or scroll with its suspended weight directly to the shaft, *c*, is far preferable to applying it or an arm and adjustable weight thereon to the shaft, *c*, for in the latter case the weight has to be very materially increased to produce the necessary result, as it has to operate through the sectoral lever and its pinion, and consequently has all the leverage of such to overcome in order to move the case, A. The governor we have described, has got a good name in the United States for the promptness of its action and general efficiency; but we are not aware of its having been introduced in this country.

THE STEAM YACHT MIRANDA.

About a year ago (*vide* page 329 of our tenth volume) we published a description and engravings of the steam yacht Ariel built by Mr. John I. Thorneycroft, of Church Wharf, Chiswick. This yacht attained a speed of about fourteen miles per hour, and we believe that it held its position as the fastest steam launch afloat until the appearance of the Swallow, a steam yacht built by the same maker for Sir Roger Palmer, Bart., under specification that it should beat the Ariel. The steam yacht Miranda, which forms the subject of our two-page engraving this week, has also been built by Mr. Thorneycroft, and is of the same dimensions and on the same model as the Swallow. It is 49 ft. 9 in. long over all; 6 ft. 6 in. beam, and has a maximum draught at full speed, of about 2 ft. 6 in. The hull is of Bessemer steel and the arrangement of the cabin accommodation, engines and boiler, is shown by the longitudinal section and plan, Figs. 2 and 3.

The engines are rated at 8 horse power nominal, and have two cylinders each 6 in. in diameter, with 8 in. stroke. Their arrangement, which is very simple, is shown clearly by Figs. 4, 5, and 6, these figures being drawn to a scale of 1½ in.=1 ft. The engine frames, piston and connecting rods, crank and propeller shafts, and propeller, are all of Bessemer steel.

The engines are supplied with steam by a boiler of the locomotive type, as shown by Figs. 7 and 8. This boiler has a barrel 2 ft. 6 in. in diameter, and 3 ft. 5½ in. long between tube plates. The firebox casing is 1 ft. 10½ in. long outside, by about 3 ft. wide at the bottom, while the top is flush with the barrel, as shown. The bottom of the firebox casing is 1 ft. 8 in. below the centre line of the boiler. The boiler contains 74 brass tubes 1¾ in. in diameter outside, and it has 116 square feet of heating surface. The firegrate area is 4 square feet, and the boiler is fired from the sides, as shown. The inside firebox is of copper, the plates being ⅜ in. thick, with the exception of the tube plate, which is ½ in. The outer shell is of Bessemer steel, all the plates being $\frac{7}{16}$ in., with the exception of the smokebox tube plate, which is ⅜ in., and the front plate of the firebox, which is ⅝ in. thick. The boiler is worked at a pressure of 120 lb. per square inch.

The Miranda was hastily launched last June for the Henley Regatta, where she was engaged officially as umpire's boat, and where she attained a speed of 16.8 miles per hour against the stream, working with 100 lb. steam. Since then the engines having been worked at the full pressure, 120 lb., this speed has been exceeded. In a run between Vauxhall and Westminster Bridge, with the stream, but against a strong wind, and in rough water, her speed was over 20 miles an hour, and on several occasions, between Barnes Bridge and Chiswick, a speed of 20.3 has been noted. Making due allowances for currents, these results represent about 18.4 miles per hour effective speed through the water.

Such a performance in a vessel under 50 ft. long has never before been attained, and certain phenomena noticed while the speed is being increased, demand special attention. Up to a speed of about 14 miles per hour the Miranda behaves like other vessels, her stern drawing down in the water, and producing the ordinary transverse stern wave, but as the speed increases beyond that point, this wave is left behind, and may be seen to gradually subside, leaving the wake comparatively undisturbed, at the same time the vessel's stern lifting, and the screw again appearing above the surface of the water, as when the boat is at rest. These results are very remarkable, and they seem to point to the fact that a steam vessel has not been produced capable of mounting her wave as did the passenger boats on the Lancashire canals when urged by galloping horses. This has often been aimed at in theory, but we believe that it had never been attained in practice by self-propelled vessels before Mr. Thorneycroft built the Miranda.

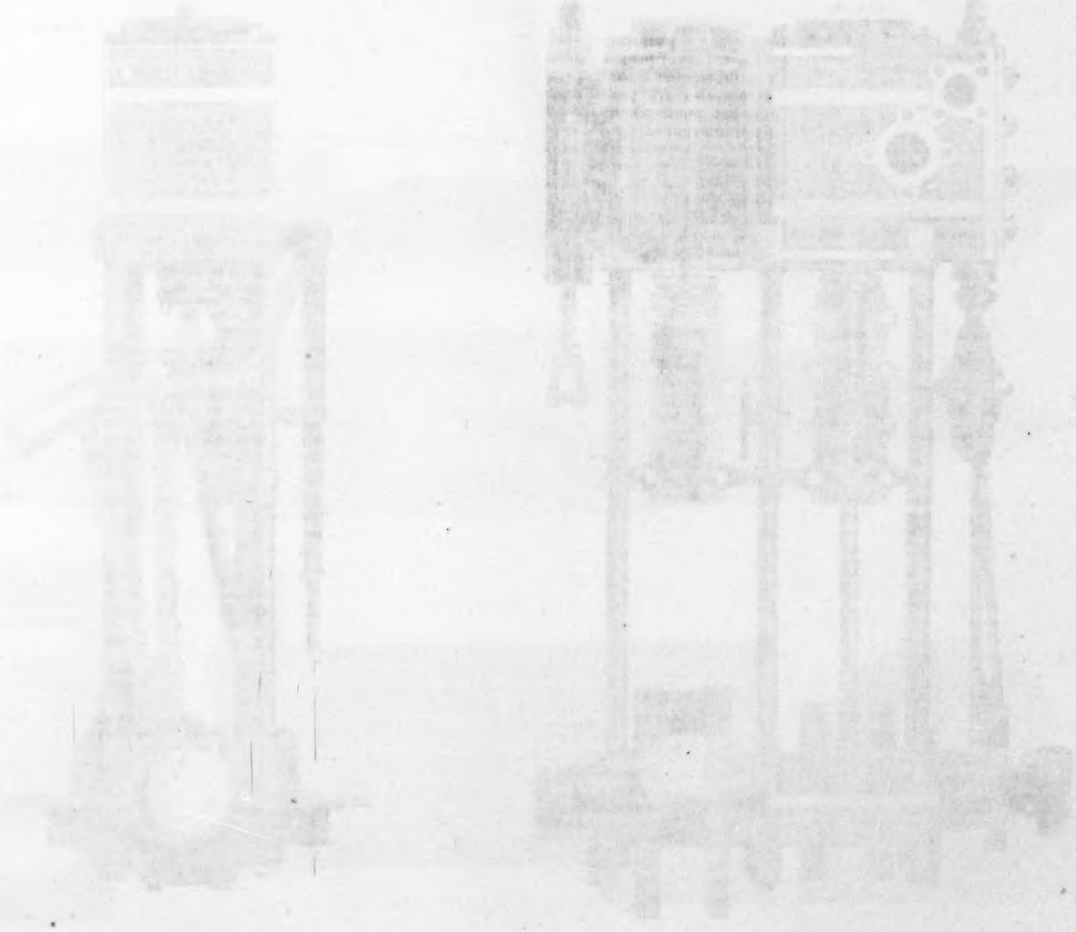
STEAM ENGINE COEFFICIENTS.

To the Editor of Engineering.

Sir,—As in this letter I will refer to some of the principles of thermodynamics, and as I, in 1860, wrote in opposition to the theory that heat and work were transmutable, I have here to state, that I, some years since, accepted that theory as the true foundation of the science of steam. This confession may seem to involve some reflection upon me—I do not think so myself. I do not accept of any doctrines, because I am told they are true, I must have proofs. At that time I was, as Mr. Smith is now, fully occupied with the duties connected with practical engineering, and had little leisure for reading or for study. The principles of thermodynamics were not then, nor are they even now presented in a form available for those so occupied. I have since had better opportunity to study this important subject, and from a careful perusal of the "Memoirs of Clausius on Heat," a revisal of Professor Rankine's works on this theory, and a consideration of the phenomena of magneto-electricity, I have satisfied myself of the truth of thermodynamics. In this study I have had to arrange the problems connected therewith in a form for practical purposes more convenient than they are usually given, and I may on another occasion lay these before your readers.

In his letter, dated October 13th, Mr. Smith begins by reminding us that he undertook to prove my *statements* to be erroneous. He, however, promised to do more than that, he was to show that even my *assumptions* were erroneous. He means to do so, thoroughly, it seems, for he sets about the destruction of my fundamental assumption, the foundation stone he himself laid with all the usual forms and ceremonies, he wants to break up; the cards themselves, he says, do not fit each other, "they do not measure the same steam nor even necessarily the same weight of steam," and that the final pressure in low should be corrected from 4.875 to 5.48. This is my fundamental assumption, and although he ought to know best whether the cards on which he based his coefficient were sufficient for the purpose, yet for this discussion I will object to the correction and maintain as my assumption the trustworthiness of the cards he now questions.

When the jacketting of a cylinder is such that it restores to the cylinder just as much heat as was abstracted from the cylinder during the period of the lower temperature of the back pressure, but without either adding to or taking from the heat of the steam, the expansion curve is a curve of non-transmission, and for steam this curve is such that the pressure by the volume by the ninth root of the volume is a constant product. This is Professor Rankine's approximation. Mr. Smith says I have made "no effort to explain why that quantity of steam cannot be found in the low-pressure cylinder." I could not do so because I was not aware it was missing, but now I will do what is far better, I will find



THE STEAM Y

BUILT AND ENGINED BY MR. JOHN L

(*For Descri*

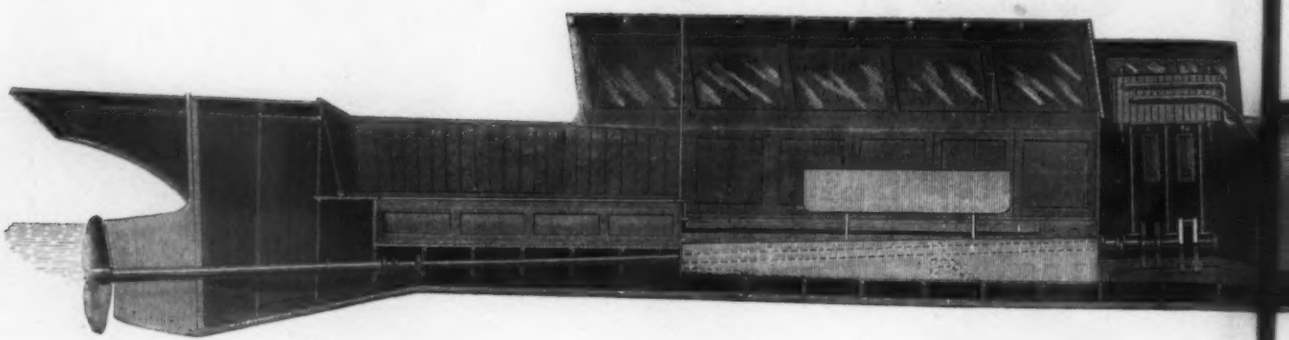


FIG. 4.

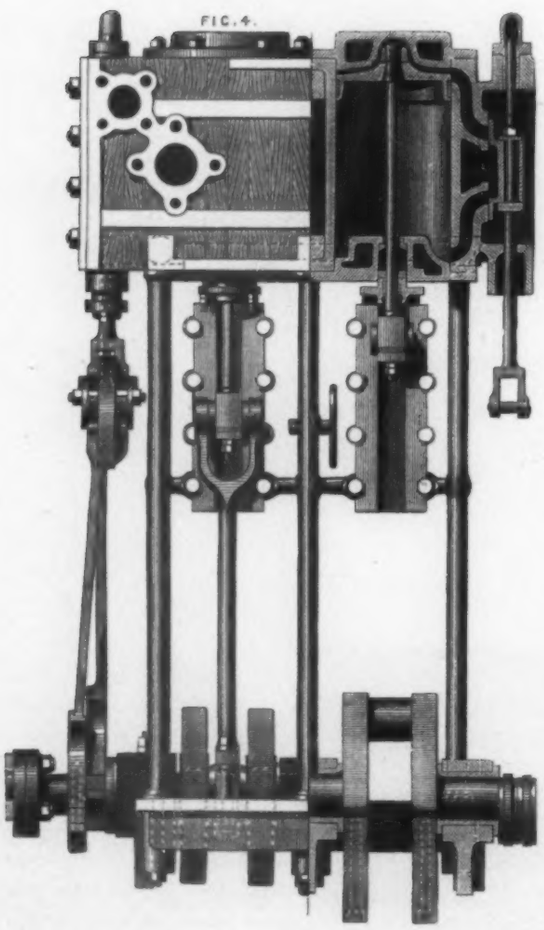
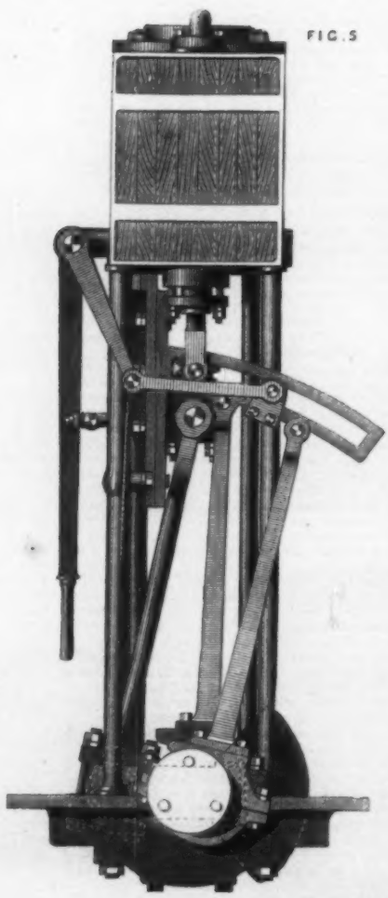


FIG. 5



YACHT "MIRANDA."

N L[illegible]ORNEYCROFT, ENGINEER, CHISWICK.

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FIG. 1

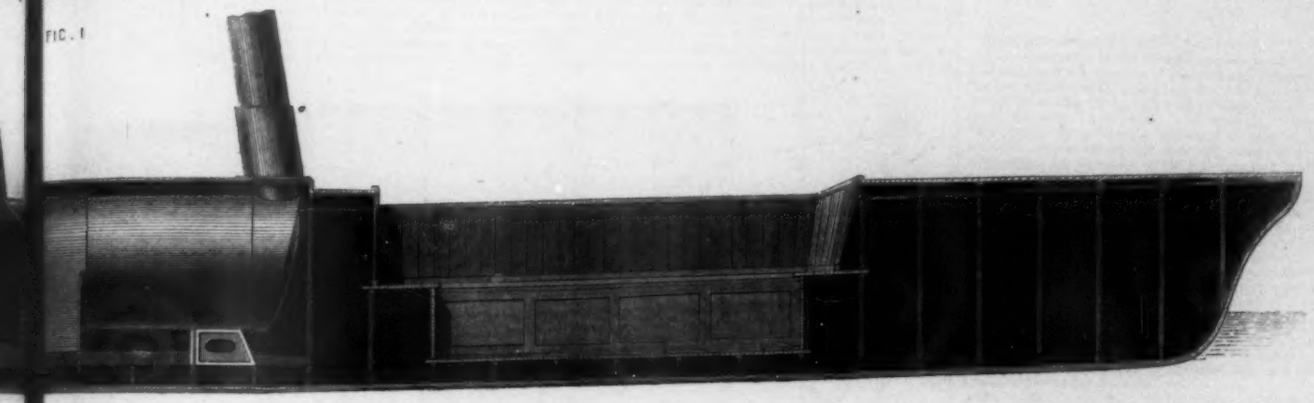


FIG. 2.

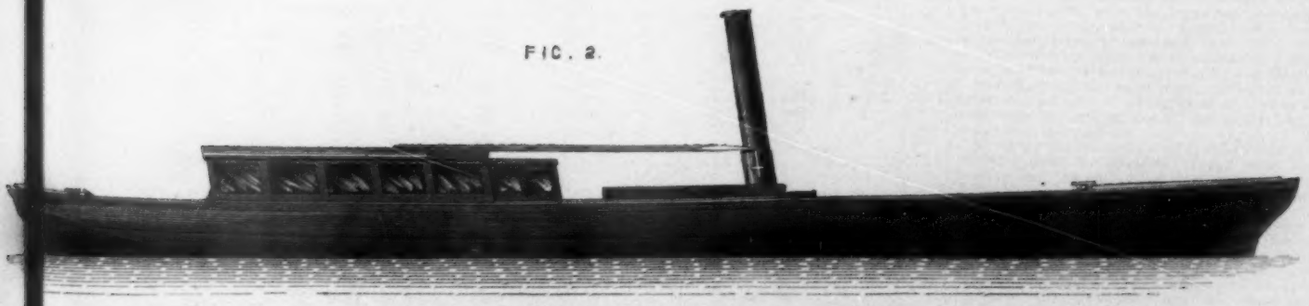


FIG. 3

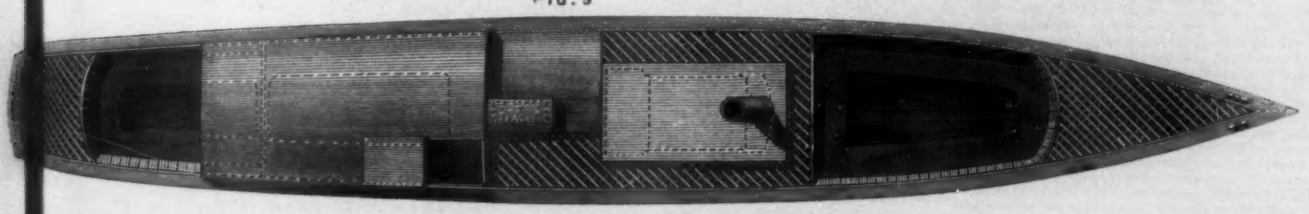


FIG. 6.

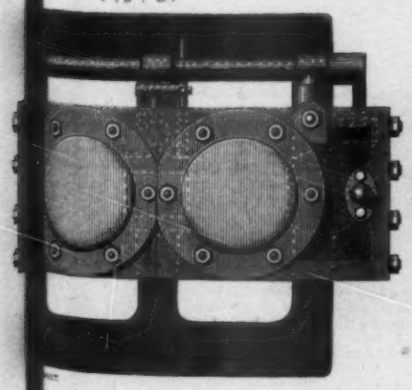


FIG. 7.

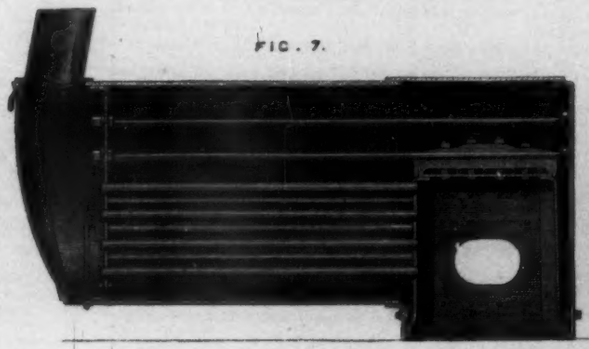
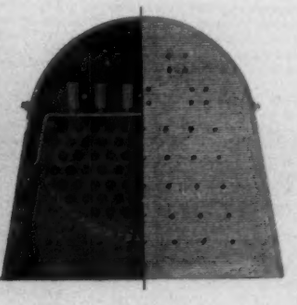


FIG. 8.



the steam for him to the last decimal place. The above described curve applies to the engine from which these cards were taken from 35.8 lb. pressure in high cylinder to the exhaust of low. It will not matter that they are well steam jacketted, and that they ought to have done better; the fact is proclaimed in the cards, the steam neither gained from nor was robbed by the metal of the cylinder.

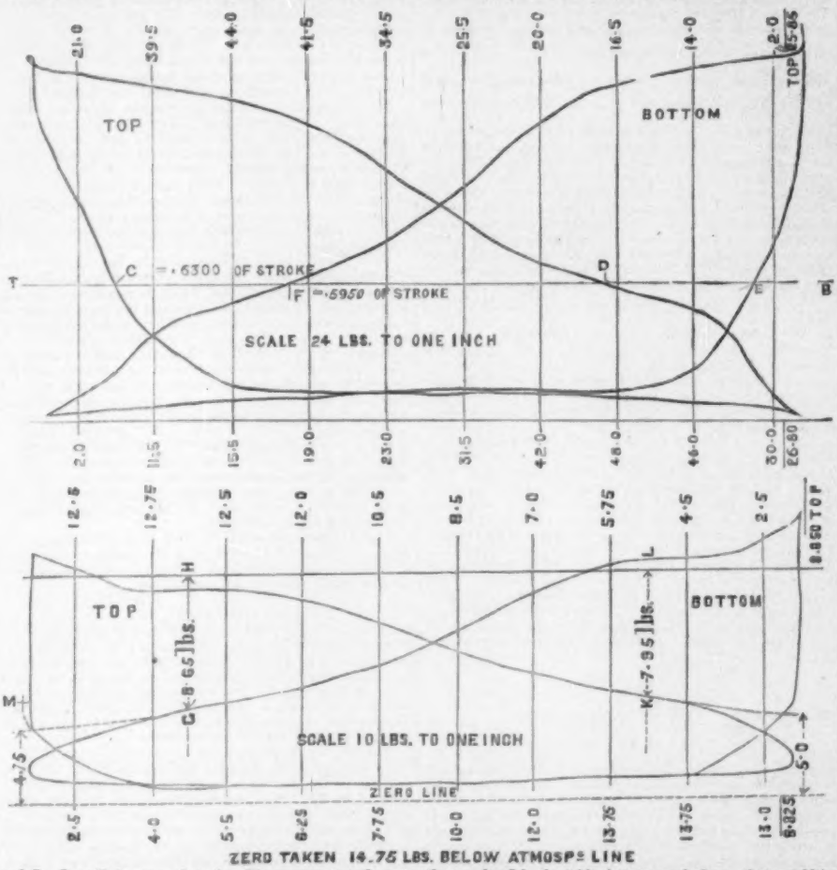
In my letter, September 19, I measured the steam used each stroke when the pressure was 35.8 lb. above zero. This steam occupied a space equal to .6125 of the stroke of the capacity of the high-pressure cylinder. The cards are reproduced here with this line added. On the down stroke, when the piston is at D, the cylinder contains steam of 35.8 lb. pressure, and of the volume, T D, T being some indefinite distance from beginning of card to include the space for clearance and passages. On the return stroke, and at the same side of the piston there is returned of that steam the amount represented by T C. The difference between these two, or the distance, C D, is therefore the measure of the quantity of steam of 35.8 lb. pressure gone between D and C. It will be seen that, for this purpose, we do not require to know the position of T. Further, it involves no question of expansion; it is the difference between two volumes of steam, having both the same pressure. In the same way we get E F, the volume of 35.8 lb. steam gone between F and E.

The length of C D is	...	...	...	.630
The length of F E is	...	...	...	.595
				2)1.225
The mean length =	...	...	...	.6125

As the low card does not continue its expansion to the end of the stroke, I will follow it, only to four-fifths of the stroke, that is, to a little before the exhaust opens. These positions are shown by the ordinates G H and K L. At G H the volume of the steam used each stroke fills .8 of the low cylinder, but at K L it fills a little more than .8. This addition is the distance past end of card at which the left-hand compression curve would, if continued, be the same height as the point K. The cross at letter M shows this distance, it is .0054 of the stroke past the beginning of the diagram. In the meantime I will neglect this amount, but will deal with it before I conclude this letter. The other card requires no correction of this kind.

To measure this .8 in capacities of high-pressure cylinder we have to multiply it by 5.58, the ratio between the cylinders, areas; $5.58 \times .8 = 2.864$. We have now to expand the steam filling .6125 into 2.864. That I may not unnecessarily grieve Mr. Smith, I will not even hint that there is a ratio of expansion involved in this. I will only deal with the ratio of volumes, and he surely will not dispute that that is $\frac{2.864}{.6125} = 4.676$.

We can now, from Professor Rankine's formula, find the pressure at G H and K L for a curve of non-transmission


TOP
BOTTOM
C = .6300 OF STROKE
F = .5950 OF STROKE
SCALE 24 LBS. TO ONE INCH
SCALE 10 LBS. TO ONE INCH
ZERO LINE
ZERO TAKEN 14.75 LBS. BELOW ATMOSPH^E LINE

We have to divide the pressure 35.8 by 4.676, and by the ninth root of 4.676. Working by logarithms we get the same by dividing 35.8 by the ten-ninth power of 4.676, thus:

log. 4.676 = .6698745
10
9)6.6987450
.7443050
log. 35.8 = 1.5538830
log. 6.450 = .8095780

And 6.45 is, therefore, the pressure which the steam will have at .8 of the low cylinder, if it has expended under pressure, that is, doing work. This journal is read by many who do not use logarithms; for them I will repeat this calculation.

The ninth root is the cube root of the cube root. In using a table of cube roots, such as is in Molesworth's "Pocket Book" it is generally necessary to use the following dodge to make the table available. The nearest number to 4.676 is the number 5 in the table, but to work from that would be very inaccurate. We have to divide by the cube of 2 and then multiply the root found by 2. For the next step, in this instance, we would have to do the same again, and therefore, we need not multiply the first root by 2, and then we will have to divide by 4 instead of by 8, and at last we multiply by 2. It might have been necessary to have divided by the cube of 3 or of 4 instead of 2, the object being to make the number less than 1.

To proceed then, $\frac{4.676}{8} = .5845$, using Molesworth's table, and taking the mean between 584 and 585 we get .8320. Dividing by 4 gives .209, of which the cube root is given .5934, and twice this is 1.1868, which is the ninth root of 4.676. Then

$$\frac{35.8}{4.676 \times 1.1868} = 6.45$$

(the same as found by logarithms.)

If this pressure agrees with the pressures actually shown on the low-pressure card at G H and K L, I will have fulfilled my promise, I will have found Mr. Smith's steam for him, and, if he had offered a reward to the finder when he advertised the loss, I would be then, as the finder, entitled to that reward.

I ask the editor of this journal to reproduce* from the same blocks the cards under dispute. I have carefully placed the lines G H and K L at eight-tenths of the stroke, but I ask any reader himself to divide the cards given on the 15th September, and to measure the ordinates from the atmospheric line to the curve. The one G H is 6.65 lb., the other is 7.95 lb. I have not used the zero line for this measurement, as its position in the figure does not agree with the pressure of the atmosphere given, 14.75; on the card the zero line is at less than 14.5. The zero line is not a part of the work of the indicator, but the atmospheric line is, and, therefore, on every ground, I am entitled to measure from that line. The pressure of the atmosphere is given as 14.75.

14.75 − 8.65 = 6.70
14.75 − 7.95 = 6.80
2)13.50

Mean pressure at G H and K L = 6.45 lb.

I ask the reader kindly to make up his mind as to whether I have proved the identity of the quantity of steam found in the low cylinder with that which has left the high, because it will be an easy thing, and a likely thing, for Mr. Smith to begin his next letter with, "In your last issue Mr. J. MacFarlane Gray merely reiterates at greater length the opinions expressed in his previous letter without at all establishing the accuracy of the statements I undertook to prove erroneous." I am afraid that, judging from his past letters, I cannot expect either to have his thanks or his gratitude for my having found his lost steam. He used the word pompously before, he can now say that after finding his lost steam, I used it for a steam-whistle and annoyed himwith it.

Having arrived at .8 of the low stroke with 6.45 pressure, we can either stop at once to the end of the stroke, $6.45 \times .8 = 5.160$, the pressure due under mathematical conditions, that is, doing no work, or we can divide 6.45 by 1.25 and by $1.25^{\frac{1}{9}} = 5.0337$, the pressure at the end of the stroke if the steam had to make the space for itself, or to do work. This is still a little above 4.875, but the 4.875 is not a part of my assumption, it is not given by the indicator, and therefore I have nothing to say about it.

Mr. Smith has used 14.75 for the pressure of the atmosphere if he will tell me why he has added the 5 to the usual 14.7 I will then tell him what I mean to do with the little bit of compression at M.

As to the cards not necessarily showing the same steam, it is possible, unintentionally, to cook the cards by taking the low-pressure cards when the engine has been racing and the high pressure one when the engine is being brought up by the screw becoming immersed. But surely these cards would not be taken under such circumstances or they would never have been put forward as data for a coefficient.

In another way the cards might be faulty; if the slide valves were jamming or cutting so as to work by jumps we might have an irregular cut-off, but surely these engines were not in this condition.

By taking the cards of the set at different times, the high when the engine is at full speed, the low when the engine is going slow, the effect under consideration would be produced; but surely these cards would not be taken under such varying circumstances.

When the engine is moving at any reasonably uniform speed, and the cards are taken in succession, first, one from the high, then one from high and one from low, then one from low, completing the set in one and three-quarter revolutions, the cards will always show that the same steam has passed through both cylinders. Surely these cards would be taken under just such circumstances.

With regard to the reduction of pressure below that due to steam expanding under mathematical conditions, that is without loss of energy or according to Mariotte's law I have not said that it is loss, although Mr. Smith says I do. My words are, "we should measure the steam either unexpanded or expanded without loss of energy, otherwise the work or heat abstracted will not be included in our measure." (misprinted "one measure.") The heat in the steam is *energon* or energy, that which has disappeared at the end of the stroke has given out as *ergon* or work. The word energy means literally *in work*, our energy is the work we have *in* us. The work we do, wastes our energy, but it is not a loss if the work done is worth the waste. When work is done by steam and no heat added to or taken from the steam, the area of the rectangle of pressure by volume is continually becoming less at the uniform rate of one-ninth of the addition to the diagram of expansion. The defect in pressure as compared with Mariotte's law will, therefore, be just one-ninth of that part of the gross effective pressure that is due to the expansion.

The coefficient for the work done by expansion alone when that is accomplished with non-transmission of heat is found thus: Rule—Divide nine by the ninth root of the ratio of volumes, and deduct the quotient from nine also. One added to this is the coefficient for the work of admission and expansion combined.

The product of pressure by volume may be taken as a measure of the energon, and every foot-pound in that product represents nine foot-pounds of work. This energon product wastes at the rate of one foot-pound of energon product to nine of work. Including the work of admission one foot-pound of energon product contains ten foot-pounds of work. If this approximation were a physical law, true for all pressures, an engine with a cylinder large enough to contain the two H's, and with an early cut-off, and no loss would give a diagram with a coefficient necessarily something less than 10. It is well to bear this in mind, for in these days of increasing expansions and diminishing consumptions, we may soon have such a coefficient presented to us as a realised fact.

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* It would have been impossible to have added to the original blocks the lines previously referred to by Mr. Gray. We have, however, had the blocks reproduced with the greatest care, so that they are faithful copies of the originals, with the exception of the addition of the lines just mentioned. We may add that the shrinkage of the paper after leaving the press renders it difficult to obtain minutely accurate dimensions from printed diagrams. We have ourselves frequently tested this shrinkage, and have found it to vary from about 1½ to 2 per cent.—ED. E.

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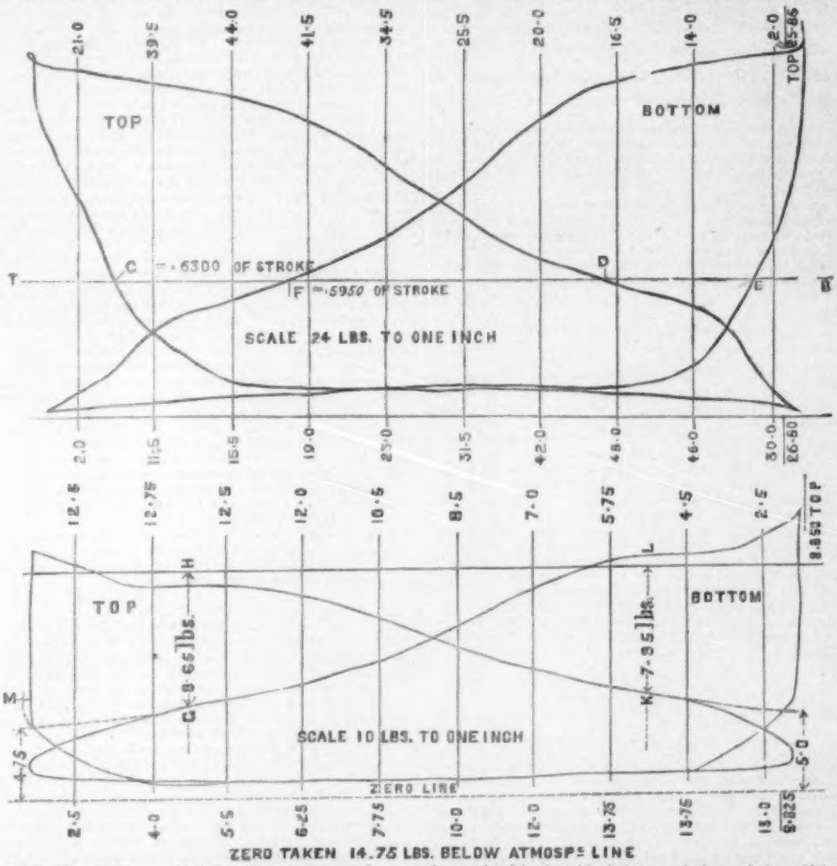
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ZERO LINE
ZERO TAKEN 14.75 LBS. BELOW ATMOSPH. LINE

* It would have been impossible to have added to the original blocks the lines previously referred to by Mr. Gray. We have, however, had the blocks reproduced with the greatest care, so that they are faithful copies of the originals, with the exception of the addition of the lines just mentioned. We may add that the shrinkage of the paper after leaving the press renders it difficult to obtain minutely accurate dimensions from printed diagrams. We have ourselves frequently tested this shrinkage, and have found it to vary from about 1¼ to 2 per cent.—ED. E.

probably to both of these. I have not the amount of space in clearance and passages; I do not think there is more than is shown in the figure with my letter on 6th October, and therefore I will suppose that part of the card to be hyperbolic, and will take the expansion in two steps—the first, according to Mariotte's law, from the average admission pressure to the line, T B, on figure herewith. The ratio of volume up to that is $\frac{.8125}{3.58 \div 11} = 1.882$. The other step has a ratio of volume equal to $\frac{11}{1.882} = 5.845$. The total gross effect from these steps will give a coefficient $= 1 + \text{hyp. log. } 1.882 + 9 - \frac{9}{5.845^{\frac{1}{9}}}$

Log. 5.845, 9).7667845

.0851983

Log. 9 = .9542425

Log. 7.3968= .8690442

$1.6032 = 9 - \frac{9}{5.845^{\frac{1}{9}}}$

.6321 = hyp. log. 1.882.

1. = effect of admission steam.

2.3355 = gross coefficient.

We have now to deduct the back pressure. I took this before as, at least 1½ lb., but that was measured from the zero line on the diagram, and that is wrongly placed. The back pressure is at least 1½ lb. per square inch. There are also some other losses, the drop into receiver, the wire-drawing between the two cylinders, and the rounding on exhaust corners. Let the sum of these, an unknown quantity, be represented by the letter x. The effective pressure by Mr. Smith's measurement is 16.167 lb., referring all to low piston. It is evident that the coefficient 2.2355 is made up of the effective pressure 16.167 lb., the back pressure 1½ lb., and the remainder x. The coefficient realised by the 16.167 is therefore $\frac{2.2355 \times 16.167}{16.167 + 1\frac{1}{2} + x}$. And, further, supposing the value of x to be nothing—that is, that beyond having back pressure 1½ lb., the engine was working up to perfection—we get the greatest possible actual coefficient to be

$$\frac{2.235 \times 16.167}{16.167 + 1\frac{1}{2} + 0} = 2.960.$$

Taking 16.167 as correct, I have shown in my former letters that the coefficient realised was only $\frac{16.167}{6.125} = 2.64$. This would leave $(2.96 - 2.64) \times 6.125 = .32 \times 6.125 = 1.96$ lb. as the value of x, the sum of the other losses beyond the 1½ lb. of back pressure.

Taking my measurement of diagrams we get a coefficient $= \frac{15.65}{6.125} = 2.55$. This $(2.96 - 2.55) \times 6.125 = .41 \times 6.125 = 2.51 = x$; or a loss of 2½ lb. in addition to the 1½ lb. of back pressure.

Mr. Smith has blown my trumpet well in his letter, but he has not forgotten himself either. He observed a blunder in my first letter, but he refrained from noticing it. Thank you, Mr. Smith, you meant well no doubt, and you shall have your reward, even the opening of your eyes to the absurdity of the position you have assumed with so much trumpeting. You say "Mr. Gray pompously challenges any question as to his accuracy, even to the last decimal place"—I do so now.

I accept your challenge with the greatest pleasure. It reads as follows: "He takes his theoretical coefficient, and from it obtains the coefficient due after the back pressure is deducted, by taking the effective pressure shown in the diagram, i.e., the pressure of imperfection, instead of the theoretical pressure corresponding to his theoretical coefficient. Thus instead of $\frac{3.398 \times 16.167}{1.25 \times 16.167} = 3.154$ as he makes it, it should be $\frac{3.398 \times 19.563}{19.563 \times 1.25} = 3.194$." This 19.563 is the sum of the effective pressure, the back pressure, and the other losses represented by x in a preceding paragraph. Mr. Smith's correction is that this should have been $\frac{3.398 \times (16.167 + 1\frac{1}{2} + x)}{16.167 + 1\frac{1}{2} + x + 1\frac{1}{2}} = 3.194$, instead of $\frac{3.398 \times 16.167}{x + 1.25 + 16.167} = 3.154$ when $x = 0$. I like to give any arithmetical hints that are likely to be needed by working men, but to give an exposition of the Rule of Three, which is what is wanted here, would be, I think, to insult even the working man. I must now notice the ending of this challenge, and I ask Mr. Smith on his copy of his letter, to draw his pen through the words given in italics. It reads: "This is certainly *not* accuracy to the last decimal place; but it is less the actual difference between the results than the *jumble of* perfection *with imperfection* in connexion with Mr. Gray's claim to infallibility that is here worthy of notice." I do not claim infallibility, but I do think every one should be ready either to maintain the accuracy of his statements, or to admit that they are erroneous. Infallibility does not belong to mortals, but if it be used in a comparative sense, I think a few more such challenges as Mr. Smith has sent me should go a considerable length towards procuring me such a diploma.

Mr. Smith then proceeds to give me a great deal of credit I do not deserve. He says I lay it "down as a law that, in order to obtain the quantity of steam, 'we should measure the steam either unexpanded' or 'expanded without loss of energy.' Well, if we should do so it is only because Mr. Gray ordains it, certainly not because the higher pressure is any better standard than the lower." I think the praise lavishly bestowed upon me here—an eulogium that might be an honour to me, and might be written on my tombstone by my grateful countrymen if it were true. Water is sent into a boiler a fluid without energy. Heat is added to it, and it becomes, in the form of steam, a store of energy. It is to get at the "*energy*" that is in the steam that we measure it at all. This "*energy*" is found in the form of pressure by volume. It is measured by that product, and this also is the measure of the cost of its production, and engineers would not measure it until the "energy" was partly out of it, but only because Mr. Gray ordains it. Prove this, Mr. Smith, and I will preserve your demonstration for the use of my biographers.

But apart altogether from the consideration of energy, there is another reason why the quantity of steam used should be measured on the high-pressure card. The datum line of an indicator diagram is generally measured an average atmosphere=14.7 lb. below the atmospheric line. But the position of the atmospheric line varies on the diagram to the extent of 1½ lb. per square inch, according to the height of the barometer. Now taking these cards from the engines on two different days, with about 3 in. difference in the barometer, say 27½ and 30½ in., but the engines working in every way the same, the two sets of cards will be facsimiles of each other, with this difference, that the atmospheric line will be 1½ lb. higher on one than on the other. Mr. Smith's terminal pressure is on one day, say, 5 lb., and on the other it will be 6½ lb. If the effective pressure be 16 lb., the coefficient on the first day will be $\frac{16}{5} = 3.2$, and with a splendid vacuum. Whereas on the other day it will be $\frac{16}{6\frac{1}{2}} = 2.46$, and a wretched vacuum. The coefficient will be explained by the bad vacuum, and perhaps the poor engineers will have to draw the air-pump buckets, and take the doors off the condenser to rectify the coefficient. Now, the engine is doing just the same on both days, and the coefficient, whatever it may be, must be identically the same. Now try measuring from the high-pressure cylinder, and suppose the measurement there on the first day agreed with that in the low, and gave a coefficient=3.2. Suppose it was measured from steam at 36 lb. pressure. The alteration of 1½ lb. on atmosphere will tell on this also, but the difference will be only one-sixth of the amount. The coefficient will be $3.2 \times \frac{36}{36 + 1\frac{1}{2}} = 3.072$. This is very much better than 2.46, and yet Mr. Smith says if we take the 3.072, rather than the 2.46, "it is only because Mr. Gray ordains it." I ask Mr. Smith, as a particular favour, to remember that it is so, because I ordain it, and every time in after years he does measure from the high-pressure cylinder, as I know he will, let him remember this, our pleasant correspondence, and say, "God bless Gray for ordaining that." When engines come, as a rule, to be tested for a coefficient, and that coefficient is taken on Mr. Smith's plan, the manufacturer would do well to remember the proverb, "Never sell your hens on a rainy day." I admit that to a small extent this affects the other measurement, just as the barrel-shaped cylinder would also affect it, but the degree in which it does so is so different that the argument cannot at all be said to be quite as available against measurements in the high-pressure cylinder.

Mr. Smith appears to claim the curve of saturation as the exponent of his cards. For sake of demonstration, I will suppose that the steam did abide by that curve. The relative volumes of the average admission pressure, and of the final pressure are, as 1 to 11 (something less than 11, but I will retain the number as before). The coefficient due to that is

$$17 - \frac{16}{11^{\frac{1}{1.6}}} = 3.227,$$

and, deducting the 1½ lb. back pressure, we have

$$\frac{3227 \times 16.167}{16.167 + 1\frac{1}{2} + x} = 2.953, \text{ when } x = 0.$$

So that, giving Mr. Smith his own way in the expansion and perfection beyond mere back pressure, the total coefficient could be only 2.953, whereas he still claims 3.15, and originally 3.32. This 2.953 is taking the largest coat that could possibly be made out of a given piece of cloth as the standard of perfection, and just in the proportion that the scrap in any case exceeded 16.17 per cent., so would the finished coat be smaller than the standard coat. I have done so at Mr. Smith's request, and find that Mr. Smith says that he has made a 3.15 coat out of what could only possibly make one 2.953.

He then asks how I get my coefficient when the measure of pressure by volume is found to be greatest at the end of the stroke. I take that measure. The coefficients found are only first approximations, and are always only limiting coefficients and always *err* in excess. They tell us that not more than a certain effect was produced by the steam, they do not say that effect was really produced, but their testimony is absolute as a limit that not more than that effect was produced. They are to be taken as limits in this negative sense, and we approach nearer to the true positive coefficients as we legitimately reduce their amount by taking as a divisor the highest product of pressure by volume found throughout the whole stroke. The whole energy in steam is ten times the product of its pressure by its volume (including its admission effect). If we have a coefficient 3, that reads that there was given out as available power by the steam not more than three-tenths or .3 of the power or energy originally stored in it. It does not prove to us, however, that even that proportion was utilised. If the product of pressure by volume is greater at one place than at another it is evident we should take that which is greatest. Either will give us a true coefficient, for if the engine did not utilise more than .255 of the energy of the steam as I state, then it must also be quite true that it did not utilise more than .232 of that energy as stated by Mr. Smith's original coefficient. But while both are equally true, surely .255 is infinitely more valuable as a limiting value. The further treatment of indicator cards for the succeeding steps in the rectification of these coefficients to give them an approximate positive value in the other sense cannot be introduced here, this letter being already a long one.

Then about the origination of this system of coefficients. When I published it in 1860 I said: "In the arrangement of these problems on the geometry of the expansion curve I have not borrowed from any work, but I have no doubt that, from their simplicity, they are familiar to many engineers, and I pretend to no novelty in their introduction." With regard to the Messrs. Elder, what I stated was simply the truth. Mr. Alexander Elder received my explanation of coefficients as new to him then. The sheet of lithographed diagrams has no date, and the statement made by Mr. Elder that it bore the lithographed date, 22nd of September, 1860, while strictly correct, is very misleading. It actually contains three different dates, but neither of them are the date of the lithograph. The Steamship Performance Committee of the British Association at different times published detailed statements of the performance of Messrs. Randolph, Elder, and Co.'s compound engines, but nowhere can I find any mention of this coefficient. I ask any one to examine Table XXIII. in the Fourth Report of that Committee: "Dimensions and abstract of performances of the Pacific Steam Navigation Company's new paddle-wheel steamships Peru and Talca." Almost every detail of performance is given, the consumption under 2 lb. per horse power, the temperature of the steam 350°, the cut-off ¼, but not one word about "coefficients." The trial trip of the San Carlos is given in the *Artisan* for March, 1860, the diagrams are discussed, and the figures of the calculation of horse power are even given, but not one word about "coefficients."

Mr. Smith then invidiously remarks about inspiration from Mr. J. McFarlane Gray. I have a reluctance to introduce here the other name referred to, but I reply to Mr. Smith's sneer by quoting Mr. Smith's bracketed clause ("all from actual terminal pressures.") If that does not reverse the sneer, I refer further to a leading article in this journal, May 4th, 1866, where these coefficients are referred to, and in connexion with Mr. Smith's sneer, I ask the reader to take the fourteenth line from the top in the third column of page 292.

To "J. J. C." I will only say that he has mixed up the different statements in my letter. I do not deduct the back pressure to find the coefficient, I only do so when scrutinising a given actual coefficient. I know that the back pressure at least must be deducted from the coefficient under mathematical conditions to find that, and a coefficient above the remainder is by so much above what is the limit of possibility. The unit of this coefficient is not the perfect coefficient due to the cut-off, but it is the duty of the steam without expansion and without loss. To compare this coefficient with the coefficient due to the cut-off is also very important, and accordingly in 1860, I said: "The practical efficiency of one rate of expansion divided by the practical efficiency of another rate gives the relative practical economy of the two rates, but this result is only true as far as the indicator reveals the circumstances of the steam in its passage through the cylinder." I think "J. J. C." will now see that between us there is really no difference.

I think I have now dealt with all that was submitted to me, and again I must just trust to Mr. Smith to point out anything I may have omitted, and by all means let me have his corrections; they do me good they do.

J. McFarlane Gray.

12, Montenotte, Cork, October 28, 1871.

P.S.—Last week I wrote the substance of the above letter discussing principles only, and meaning to allude to Mr. Smith's letter at the end. I wrote it in three sections, and forwarded two of them, the second on the 24th ult., with "To be continued." But on reading my copy an hour afterwards, I found I had forgotten Mr. Smith altogether. Feeling that this would be a disappointment to him, I telegraphed to return my MS. to be recast.

AN ELASTIC NUT-LOCK.

To the Editor of Engineering.

Sir,—In your last impression, Mr. P. M. Parsons apparently claims to have first applied the principle of elasticity to locking nuts. On this head I would quote the opinion of a third person, Professor Ludewig, of Munich, who, in an elaborate series of articles on the different modes of locking nuts (*Ueber Schraubensicherungen*), gives me the credit of having first carried out this idea, as specified in a patent dated May 29th, 1865. I beg to direct attention to this practical treatise, with its valuable lithographs, lately published at Berlin; and this may be my excuse for troubling you about such a small matter.

Obediently yours,

Fred. A. Paget.

London, November, 1871.

LEQUESNE'S COMMUTATOR.

To the Editor of Engineering.

Sir,—The commutator of M. Lequesne, recently described by your Paris correspondent, appears to be almost identical with, if indeed it is as simple as one which I devised about two years ago, and of which there is a description in a paper published by me in the *Philosophical Magazine* for January, 1870. The arrangement of conductor on the movable cylinder in M. Lequesne's instrument appears to be rather complicated; but any desired grouping of cells could, I think, be more easily obtained by the employment of the necessary number of short cylinders, such as are mentioned in the above paper, than by one long one, as the friction of the surfaces in contact becomes, on multiplication, very serious.

I am, Sir, your obedient Servant,

John Parnell.

Hadham House, Upper Clapton, November 1, 1871.

Steam Fire Engines.—Messrs. Merryweather and Sons are excessively busy in the execution of orders for steam fire engines for the French and Prussian Governments. For the former they have no less than 10 engines in hand, four of them being 1000 gallon floats. The Prussian engines are both "floats" and land engines, and capable of discharging 1100 to 1200 gallons per minute to a distance of 260 ft.

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NOTICE OF NEXT MEETING.

SOCIETY OF ENGINEERS.—On Monday evening, the 6th November, Discussion on paper read by Mr. Perry F. Nursey, on "Recent Improvements in Explosive Compounds." Should time permit, a paper will be read on "Floating Breakwaters," by Mr. Thomas Cargill, C.E.

THE "ENGINEERING" DIRECTORY is published this week on the thirteenth page of our advertisement sheet.

NOTICE TO AMERICAN SUBSCRIBERS.

In consequence of the great increase in our American connexion, we have found it necessary to establish a branch office in the United States. Communications may in future be addressed to MR. GEORGE EDWARD HARDING, C.E., *of* 176, *Broadway, New York, who is our accredited representative.*

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of* 1*l.* 14*s.* 8*d.* ($8.32, *gold*) *per annum, payable in advance.*

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ENGINEERING.

FRIDAY, NOVEMBER 3, 1871.

NARROW GAUGE RAILWAYS.

DURING the past year or so, dozens, if not hundreds, of articles on narrow gauge railways have been published by the non-technical press on both sides of the Atlantic. Many of those articles are of a moderate tone and have evidently been written with a fair knowledge of the advantages which narrow gauge railways do and do not possess; but others—and these are the majority we regret to say—abound with errors which would be ridiculous if it were not that they may become mischievous by creating a false impression on the public mind. In the United States especially, the wildest possible statements regarding narrow gauge railways have been made in many non-technical papers, and it is probably in no small degree due to this that several of the professional journals in that country are now opposing the development of the narrow gauge system, their opposition being mainly founded on the reckless assertions of many of those by whom the system has been advocated. In other words, we believe that in their eagerness to point out the fallacy of statements made by foolish friends of the narrow gauge system, several of our professional contemporaries in America have been led to lose sight of the substantial advantages which that system really possesses. Naturally a discussion has arisen from this opposition, and our own articles on the subject have been freely quoted on both sides, each party choosing those particular passages which it deemed corroborative of its own views. It is this circumstance which has led us to write again on a subject respecting which so much has been already written that it is almost worn threadbare; and we desire in the present article—even at the risk of employing arguments which we have already advanced—to state as clearly as we can the points wherein we believe several of our professional American contemporaries are wrong in their opposition to the construction of narrow gauge lines.

The opponents of the narrow gauge system found their opposition principally on three assertions; namely, first, that light lines may be constructed on the standard 4 ft. 8½ in. gauge as cheaply or very nearly as cheaply as on one that is narrower; second, that a break of gauge is a most important evil; and third, that the alleged reduction in the proportion of dead weight to paying load which the supporters of narrow gauge railways affirm can be affected with that system, is a visionary idea not supported by the results of practice. We shall consider these statements in the order in which we have mentioned them.

It must be well known to all who have read the articles on narrow gauge railways which have appeared in this journal, that we have never advocated extremely narrow gauges. When the question of what gauge should be fixed upon for the secondary lines in India was under discussion, we persistently set forward the merits of the 3 ft. 6 in. as compared with the 2 ft. 9 in. gauge, and we at the time explained fully our reasons for so doing. While admitting that the first cost of a 2 ft. 9 in. line would be slightly less than that of a 3 ft. 6 in. line laid with the same weight of rails, we pointed out that with the former gauge the rails would be subjected to greater strains by the oscillation of the rolling stock, that the effect of inequalities in the road would be greater in the narrower gauge, that the accommodation obtainable in the rolling stock would be more limited, and that altogether the saving would not compensate for the inconveniences it involved. The gauge actually chosen for the Indian lines, namely, one metre, or 3 ft. 3⅜ in., differs so slightly from that which we advocated that it would be idle to imagine that the one possesses any great advantage or disadvantage as compared with the other. The very arguments, however, which we advanced against the adoption for India of a less gauge than 3 ft. 6 in. are now being used on the other side of the Atlantic—and with considerable effect—to prove that any departure from the gauge of 4 ft. 8½ in. is unadvisable; but it may, we think, easily be shown that they are by no means applicable to such an end. All writers on the narrow gauge question who possess any knowledge whatever of their subject, are ready to admit that with the same weight of rails a reduction is effected in the cost of construction of a line per mile as the width of the gauge is diminished. The actual amount of this reduction and the ratio it bears to the diminution of the gauges is disputed—and it must, in fact, differ in almost every case where a line has to be made—but the fact that there *is* such a reduction is allowed. On the other hand, it is also allowed, even by the strongest partisans of the narrow gauge, that the diminution of the width of gauge is attended with some loss of accommodation, although the ratio in which the accommodation is deteriorated as the gauge becomes less, is also a matter of dispute. Thirdly, it is also admitted on both sides that there is no necessity that the accommodation on second-class lines—such as cheap railways must necessarily be on whatever gauge they are constructed—should equal that afforded on the main trunk railways, the term "accommodation" being here intended to have its broadest meaning.

These facts being premised, we may now enter into greater detail. If a careful examination be made, on the one hand, of estimates for lines of different gauges (and several such estimates have been published in this journal), and on the other of designs for the rolling stock of such lines, (the capabilities of such stock for running at various speeds being duly regarded), the important fact will be discovered that whereas the *rate* of reduction in the cost of construction of a line diminishes as the gauge itself is diminished, the rate of reduction in the accommodation increases with the reduction of the gauge. In other words, as a line is reduced in width below the ordinary 4 ft. 8½ in. gauge, the cost of construction at first diminishes in a more rapid ratio than the loss of accommodation, while subsequently these conditions are precisely reversed. It follows from this that the arguments advanced against the reduction of a gauge from 3 ft. 6 in. to 2 ft. 9 in. do not necessarily apply to a reduction from 4 ft. 8½ in. to 3 ft. 6 in., and it also follows that there is a certain point beyond which, if the gauge is reduced, the result is a loss of accommodation quite out of proportion to the saving in construction. The point at which this result is produced it is impossible to fix definitely, as its position will vary according to the nature of the country which the line has to traverse, and the class of accommodation which it is desired to furnish. In fixing upon the gauge for any particular district, therefore, all that can be done is to endeavour to obtain the best average results. We ourselves, taking into consideration the general features of the districts to be accommodated by narrow gauge railways, have advocated the 3 ft. 6 in. gauge, and our opinions in the matter are, we know, shared by Mr. Carl Pihl, the engineer of the Norwegian narrow gauge lines, Mr. John Fowler, Sir Charles Fox, and other engineers. Mr. Fairlie, on the other hand, has maintained the merits of the 3 ft. gauge, and he has done so with great ability, while still narrower gauges have been advocated by Mr. C. E. Spooner, the engineer of the Festiniog Railway, and others. It is not our purpose to reopen here a discussion of the relative merits of these various gauges, and we merely mention them to remark that they are probably all situated between those limits within which the gauge of greatest economy is to be found in most cases in which the construction of narrow railways is desirable. It follows, therefore, from what we have stated, that where the maximum accommodation required is less than the *maximum* (not the ordinary accommodation) which the 4 ft. 8½ in. gauge can afford, a diminution of the gauge may be resorted to with economy in all but a few exceptional circumstances, such as cases in which a short narrow gauge line would have to form a portion of a system of railways of a gauge already established. This brings us to the second assertion made by the opponents of narrow gauge railways, an assertion which we must now proceed to consider.

In doing this we may state to commence with, that we are perfectly willing to allow that a change of gauge is an evil; but we believe it to be an evil the importance of which has in many instances been greatly exaggerated. It is an evil that the goods sent by ordinary railways have to be transferred to horse-vans for delivery at our houses; but no one would on that account advocate the abolition of such vans. Even if it were permissible, it would not pay to construct lines through all the streets of our towns and cities for the delivery of our goods direct from the railway waggons; and just in the same way it will not pay for the standard lines to be extended to all parts of a thinly populated district. In the latter case light narrow gauge lines may be profitably employed in the same way as horse-vans are in the former, and in either instance the "break of gauge" becomes sanctioned by the benefits which result from resorting to it. And here we may remark that the evils of a break of gauge are by no means entirely avoided by supplementing main lines with cheap branch lines of light construction, but of the ordinary gauge. Such lines, if really light, require a special light rolling stock of their own, and hence the transshipment of goods from the main line to the branches or *vice versâ* is as much a necessity as if the lines were of different gauges. This is a fact which has been frequently pointed out, but is one which is still constantly ignored by the opponents of narrow gauge railways.

Next, it must be remembered, that in the case of narrow gauge lines being worked as extensions of main lines of the ordinary gauge, the greater proportion of the goods, of which the transport is affected by the break of gauge, are of the character best adapted for economical transshipment. In the case of thinly populated districts, such as narrow gauge lines are expressly intended to develop, the vast bulk of the produce to be transported to the main system consists of raw materials, such as timber, minerals, or agricultural products, and it is just such materials as these that can be transshipped with the least expense and liability of damage. Manufactured articles passing in the opposite direction, namely, from the ordinary to the narrow gauge, will have to be transshipped it is true; but their tonnage will necessarily form but a small percentage of the whole traffic. If we take the average cost of transshipment of goods, including interest on cost of plant employed, at 1½*d.* per ton, we shall probably be materially overrating the expense, even in districts where labour

is highly paid, and yet it may be shown that even at such a rate the interest on the saving effected by substituting a narrow for the ordinary gauge, in a line of the moderate length of 50 miles, would suffice to balance the cost of transshipment of a larger tonnage. Let us suppose, for instance, that the saving effected by adopting a 3 ft. 6 in. instead of the ordinary 4 ft. 8½ in. gauge, was but 200*l.* per mile (and in many districts it would be double this), then the saving on 50 miles would be 10,000*l.* The interest on this saving, taken at 5 per cent. only, would be 500*l.* or 120,000d. per annum, and taking the cost of transshipment at 1½d. per ton, this would suffice for transferring 80,000 tons of goods annually, or 260 tons per day for 300 days in the year, no mean amount of traffic. This fact, we think, speaks for itself.

So far we have only spoken of narrow gauge lines as extension of railways of the ordinary gauge; but it must be borne in mind that there are numbers of districts where the narrow gauge system would be entirely independent of lines of any other gauge, and where, consequently, the question of break of gauge would not come into consideration at all. The advantages possessed by the narrow gauge in such situations we shall point out presently when speaking of the third argument advanced by the opponents of the system.

The assertion, that the proportion borne by the dead weight of the rolling stock to the net load carried cannot be reduced by reducing the gauge, is true when regarded in its broadest sense; but it is not true when its application is limited by the conditions to be fulfilled in ordinary practice. We have ourselves frequently pointed out that the adoption of a broad gauge does not necessarily involve the hauling about of an undue amount of dead weight, so long as the size of the wagons is not limited, and full loads can be obtained. In other words, it would be possible to construct a wagon for a 7 ft. gauge which would have as small a dead weight in proportion to the full load carried as the best wagon which could be built for a gauge of 3 ft. 6 in.; but the former wagon would probably have to possess quite four times the floor area and eight times the capacity of the latter, and it would therefore be of a very unhandy size for the ordinary exigencies of traffic. The advantage of the narrow gauge system consists, therefore, not in its enabling the wagons used on it to be built with a less proportion of dead weight than could possibly be the case with wagons built for a wider gauge; but in its enabling wagons *of a size convenient for the general requirements of the traffic to be met with is thinly populated districts*, to be constructed with such a less proportion of dead weight; or, in other words, it enables smaller vehicles to be used without causing the proportion of dead weight to full paying load to be increased beyond the best results obtainable on the ordinary gauge. As in the construction of the line itself, however, there is a limit beyond which the decrease of the gauge ceases to be of any practical benefit in the way just named, the diminution which it causes in the accommodation eventually more than counterbalancing its advantages in other respects. It is this fact, which we have pointed out on previous occasions, which has always led us to oppose the adoption of extremely narrow gauges, but our arguments against such gauges by no means apply to a reduction from a width of 4 ft. 8½ in. to say about 3 ft. 6 in.

The fact of the narrow gauge system enabling smaller vehicles to be used without increasing the proportion of dead weight to full paying load leads to practical advantages which appear to us to be underrated by the opponents of that system. Apart from the well-known fact that it is easier to insure full loads for the smaller carriages or wagons—thus keeping down the proportion of dead weight, and at the same time fulfilling the requirements of ordinary traffic—the smaller vehicles offer other advantages, and notably that of being more readily handled at stations. The actual total amount of labour expended in loading up wagons and making up a train of a given weight may not be greater if the train is composed of 10-ton wagons than it would be if the train consisted of wagons carrying but 2 tons each; but whereas in the former case several men would be employed a short number of hours, in the latter case the work could be done by a much smaller number of men employed a proportionately longer time. In the case of stations contributing but a moderate amount of traffic this is a great convenience, as it enables a small staff to be kept continuously employed instead of necessitating the maintenance of a large staff whose time would be but partially occupied. In the case of slight accidents, also, such as derailment, the moderate size and weight of the narrow gauge stock greatly tends to prevent expensive and vexatious delays.

The length to which this article has already extended warns us that we must leave for future notice some features of the system under consideration, but we cannot conclude without referring briefly to the connexion between narrow gauge railways and the Fairlie engine. This is a point concerning which much misunderstanding appears to exist on the part of certain of our American contemporaries, and it appears to us to be desirable to point out wherein this misunderstanding consists. It has been urged, for instance, by the *Chicago Railroad Gazette* that on the one hand, if the narrow gauge system is good for thinly populated districts, its advantages should be available whether Fairlie engines are used on it or not; and that, on the other hand, if the Fairlie system is good, its advantages should be as apparent on the ordinary gauge as on narrower lines. The fallaciousness of such arguments will, we think, be apparent if the questions at issue are more closely considered. It is a well-known fact that a given weight of goods can be transported more economically in a few heavy trains than in a greater number of trains of lighter weight, so long as the adoption of the former system does not entail the employment of locomotives of a class destructive to the line. The greater the weight of a train the less is the proportional cost of the wages of the men in charge, while the heavier the trains also the greater is the tonnage which any given line will be capable of transporting within a given number of working hours, and the less occasion is there for double shifts of signalmen, &c., to accommodate night traffic. We thus see that to obtain the full benefits of a narrow gauge line, the trains worked on it, although composed of units of small weight, should consist of such a number of those units that the weight in the aggregate is fully equal to that of heavy trains on the ordinary gauge. But so long as the ordinary type of locomotive is adhered to, it is impossible to construct engines capable of hauling such trains on narrow gauge lines without resorting to an excessive weight per wheel, and it is here that the Fairlie system steps in, and solves the difficulty. The Fairlie system, in fact, enables very powerful locomotives to be placed on a line which would otherwise accommodate engines possessing but very moderate hauling power, and it in this way vastly increases the capabilities of a narrow gauge line, and enables it to accommodate an amount of traffic which could otherwise only be carried on on a wider gauge. It is in this way that narrow gauge railways and the Fairlie system are so intimately connected, and there is, as we have recently pointed out, ample evidence that as the construction of narrow gauge lines is extended in districts where a heavy traffic has to be accommodated, this connexion will necessarily become still more intimate. The prejudice with which the Fairlie system was at one time regarded in the United States (as, indeed, it was elsewhere) is, we are glad to find, rapidly wearing away as a knowledge of the features which distinguish it become better known. It is still, however, by no means uncommon to find in the pages of American technical journals evidence of the misconception with which Mr. Fairlie's plans are still regarded in some quarters. Thus we were much amused a few weeks since at finding in the *Chicago Railroad Gazette*, a letter from a gentleman who evidently prided himself greatly upon his practical knowledge of locomotives and their management, who yet announced, as if it were a brilliant discovery, that a Fairlie engine with two six-wheeled steam bogies had more working parts that an ordinary four-coupled engine of less than half the power, and without its tender! The same individual also displayed his intimate acquaintance with the extent to which tank engines are now in use, by announcing that the plan of carrying the fuel and water on the engine was impracticable on account of its being impossible to arrange the springs so as to suit the variations of load! The letter was, in fact, so ridiculous that we should not have noticed it had it not been for the prominent position assigned to it in the important journal in which it appeared. It is of course of no use replying to the assertions of men of the class just referred to; they must be left to inform themselves of the real facts of the subject on which they write, and when they have done so, they will cease to require answering.

INDIAN HARBOURS.

THERE are perhaps few, if any, countries in the world possessing so extensive a sea-coast as the East Indies, and yet provided by Nature with so few natural harbours, or even facilities for their construction. Until the occupation of India by England, it is very questionable whether she possessed any sea-borne trade, excepting from port to port, whilst the majority of her exports to Europe found their way along the old trade route through Persia to Turkey, or to the Mediterranean Sea near Alexandretta. In those days it is very questionable whether Southern India had any export trade at all, or it is very certain that Akbar, or some of the other princes who have left such wonderful memorials of their reigns in the magnificent structures and works of irrigation which have so greatly distinguished them, would not have failed to have provided the necessary facilities for navigation in the shape of harbour accommodation. The total absence of roads in the Peninsula of India, even up to a comparatively recent date, rendered any large export trade impossible, but now a single railway is capable of bringing down to the sea any amount of produce that the intersected country is capable of producing, and hence the provision of improved harbour accommodation has become a necessity, and that, not only in the interests of the districts growing exportable produce, but also the immediate wants of the country for imported goods. Although India abounds with what are called ports, adapted for small coasting trade, she possesses but few that are capable of accommodating European vessels of the present type. For the purposes of economy in conducting a large trade, vessels are now constructed of such huge proportions, and sailing vessels are so rapidly giving place to steamers, that larger and better-equipped harbours for their accommodation have become amongst the chief requirements of the age, and India has as much need to be furnished with them as any other country in the world, while, with increased railway facilities between the interior and the coast, this need will rapidly extend. Taking a hurried glance round the map of India, we find Kurrachee the most westerly harbour, and one which, while likely to become the most important—especially since the opening of the Suez Canal, and certain to become still more so in the event of the long-talked-of Euphrates Valley Railway being at some future time undertaken—is also possessed of the greatest facilities for improvement. Works have now for many years past been in course of construction at Kurrachee with the view of improving its accommodation, and are still dragging on their slow progress, instead of being rapidly completed in a manner that would be both most economical in the long run, and most advantageous in all other respects. Upon the completion of the Indus Valley Railway, which forms one of the State lines to be immediately undertaken, Kurrachee will become the direct port for the Punjab, and therefore most important from a political and military, as well as from a commercial point of view. The progress of the works here has several times been noted in the columns of ENGINEERING, so that they need no further remark upon the present occasion. Next to Kurrachee comes Bombay, which is destined to become the commercial capital of India, even if it may not be so considered at the present time, connected as it is with the North-West, with Calcutta, and with Madras by direct first-class railway communication. Besides these two ports, there is not one other of any importance along the entire western coast of India, with the exception of Carwar, or Sudasceghur, which, it is hoped, will soon have a direct railway communication with the most important cotton-fields of Dharwar and the Central Provinces, and which will then form the entrepôt for the produce, which, at an evil moment, caused the Indian Government to embark upon that most unfortunate enterprise known as the Godavery Navigation Works. Along the Madras coast, on the eastern seaboard, there is no important commercial port south of Madras. Here there exists but an open roadstead, where, some years back, a pier was constructed to facilitate the loading and discharge of vessels. Several projects have from time to time been promulgated with the view of constructing a suitable harbour for shipping, the most promising of which is that known as Blackwood's Harbour; nothing, however, has as yet been undertaken with the view of providing the much required accommodation. North of this

are the harbours of Coringa, Cocanada, and Masulipatam, but these are so choked up with the accumulating silt, brought down by the several rivers falling into the Bay of Bengal, that very expensive works would necessarily be required for their improvement and subsequent preservation; and, besides this, not being connected with any railway communication with the interior, they would necessarily be dependent upon river traffic for the greater portion of their trade, which, in the present day, is hardly sufficient to give them a position of any significant importance. It is difficult to conceive any port rising to a prominent position that is many miles removed from the only recognised means of inland communication, and therefore, until a system of railways shall have been constructed for their benefit, it is not likely that these ports will rise to the position of anything above a second-rate importance. We next come to Calcutta, with its difficult approach, by means of the river Hooghly, which, as being the recognised capital of the empire, must always command an important trade; but there are no docks here of sufficient importance, and the greatest improvement introduced in recent years, has been the construction of jetties for facilitating the loading and discharge of cargoes. Many schemes have, from time to time, been put forward with the view of constructing docks, some of which have been proposed to be placed above Calcutta, and others below it; but none of these suggestions have ever been further developed, owing to the unwillingness of the Government to aid them with pecuniary assistance, whilst the construction of such works by means of private enterprise appears to be a thing almost unknown in our Eastern possessions, not because Europeans are unwilling to come forward with their energy and capital, but because the natives of the country will not join them in the enterprise. Thus the Indian Government is, on all occasions, called upon to give a guarantee of interest upon the capital necessary for their construction, which is but an indirect mode of making the whole country contribute towards the formation of those works which are evidently for its especial benefit. There must, of course, be a limit to the extent to which any Government can give such guarantees; but, failing assistance, the only alternative appears to be that works of this nature should be constructed by the State itself, and, considering that it can raise money at 4 or 4½ per cent., it is clearly more to its interest to undertake them itself, than to pay an interest of 5 per cent. to private capitalists for the advance of money for the construction of individual works. Passing Calcutta we come to the river Mutlah, upon which the Port of Canningtown was some time since established by private capitalists, but recent advices report that it has entirely collapsed as a speculation, and all the lights on the river have now been withdrawn, with the exception of one at the mouth of the river, and thus Canningtown has ceased to rank as a port.

The recent deputation of a harbour engineer to India, from this country, shows that the Government is keenly alive to the importance of providing fresh facilities for shipping, and it is to be hoped that his investigations may ultimately lead to some practical results; but, in the meantime, the importance of the issue at stake must not be overlooked, for it will be useless to construct a gigantic system of railways connecting the interior with different points on the coast if improved harbour accommodation is not at the same time provided for shipping the produce that they will bring down.

FIRE-PROOFING BUILDINGS.

In a long article the *Times* of yesterday discusses the possibilities of a disaster to London similar to that which destroyed Chicago, and points out with much truth, that while the wealth and trade of the Metropolis increases every year, and while its growth is never ceasing, the real commercial area is almost as restricted as it was at the time of the Great Fire, and that it is almost impossible that it should extend itself. As a necessary consequence, the accommodation available for the vast stores of merchandise always in stock (and the present actual value of which is estimated at 100,000,000 sterling), is very insufficient, despite the facts that warehouses are made more lofty, and cellars excavated more deeply, that buildings never intended for stores are used for purposes to which they are entirely unsuited, and that merchandise is crowded together in a way that is incredibly dangerous. Moreover, the minor industries, which are inseparable from every large warehouse, are carried on under conditions which endanger constantly not only the establishments to which they belong, but the entire surrounding district, as, for example, in the workshops, generally cellars, where packing-cases are made. These shops, which are attached to nearly all warehouses, are lit with gas, are full of dry wood and shavings, and constitute an ever present source of danger. It is pointed out in the *Times*, that despite the combinations of stone and iron, recognised as fireproof buildings, the commercial centre of London is full of fire traps of its own special kind, just as Chicago owned her acres of inflammable roofs, and her hundreds of wooden houses.

Ample experience has shown that there exists no real security in so-called fire-proof structures. Iron and stone buildings, uninflammable as they are, yield with comparative facility when exposed to the fervent heat of a conflagration, the stone disintegrates and falls, the iron twists and bends, until it ceases to perform its functions, and the fate of a fire-proof house is as certain as that of one not guaranteed as capable to resist the flames, whilst the danger to firemen and others in the vicinity is infinitely greater in the former than the latter structures.

Nothing but an entire reconstruction and extension of the City of London can ever secure her from all danger of a vast and overwhelming catastrophe, and such a measure as this is manifestly impossible. But much might be done to reduce the risk, and to localise conflagrations. A strict classification of merchandise, and its subdivision as far as possible, and, above all, a strict attention to those precautions, would check or arrest a fire at its commencement.

We have from time to time called attention to the remarkable properties possessed by Mr. F. Ransome's silicious paint, and on the 7th of July last we recorded some very interesting experiments that were conducted with a view to test its powers of resistance. A light timber structure partially coated with the paint was ignited, and while the unprotected portion was speedily reduced to ashes, the rest remained in a serviceable condition, burnt of course on the unpainted side, but uninjured on the other, and that to some considerable thickness.

Again, beams covered with the composition have been exposed to the fierce action of a fire during some hours, until, in fact, the wood was entirely destroyed, without affecting the condition or form of the paint, which thus acts as a practically perfect medium for isolating a conflagration. We have over and over again insisted upon the policy of universally employing this paint for the protection of the wood and stone or brickwork of buildings; of its efficiency there is not the least question, and although it could not, of course, resist the action of a conflagration already in full force, it would arrest the progress of the flames and prevent the ignition of inflammable materials rendered capable of withstanding fire by its aid.

We have only just now touched upon a subject which is at the present moment especially full of interest, but so soon as some experiments which are about to be conducted with the material are completed, we shall again refer to it, and in laying the detailed results of the trials before our readers we can give them every opportunity of satisfying themselves of the value of the silicious paint.

THE MESSAGERIES MARITIMES.

This great enterprise, which, by reason of "events," has changed its designation during the last few months from that of Messageries Impériales to the nomenclature given above, appears to have passed tolerably well through 1870, albeit that it was a year of trouble and distress to France and everything connected with that country. At the same time the dividends necessarily and unavoidably experienced a considerable fall, the 9 per cent. of 1869 becoming 5½ per cent. in 1870. This was, of course, an adverse result, but it is perhaps rather surprising that any dividend at all should have been forthcoming in a period of such general French disaster. The total receipts of 1870 from all sources are returned at 1,716,671*l.*, while the total expenses of the year are set down at 1,535,794*l.*, leaving a profit of 180,877*l.* Of this sum, 47,022*l.* was absorbed in the payment of interest on obligations. Of the balance of 133,855*l.*, 6693*l.*, or 5 per cent., was carried to the reserve fund in accordance with the 35th article of the statutes, and 126,500*l.* was devoted to the payment of the 5½ per cent. dividend. The balance, or 662*l.*, was carried forward to the credit of the current year. Even the reduced rate of dividend which was maintained could not have been secured but for a curtailment in some of the services of the company, and the continuance, in spite of the pressure upon the French Treasury, of the large subventions accorded to the company by the State.

But it is rather with the working operations than with the financial position of the undertaking that we have to deal. The capital represented by the fleet and plant of the company in a new condition was estimated at the close of last year at 4,182,370*l.* The corresponding total at the close of 1869 was 4,030,234*l.*, so that the capital account may be said to have been increased during 1870 to the extent of 152,146*l.* The lengthening of the hulls of some of the company's steamers is considered to have given the fleet a plus value of nearly 320,000*l.*, but the value of the company's naval plant, buildings, &c., at the close of 1870 was estimated to be 96,000*l.* less than at the close of 1869. The capital engaged in the building of new ships at the close of last year was also about 72,000*l.* less than at the close of 1869. After making these deductions from the first plus value of 320,000*l.*, we arrive at the total of 152,146*l.* already given as the actual expansion of the capital account last year. The steamers added to the company's fleet in 1870 were the Sindh, the Peiho, and the Ava, all three vessels of 500 horse power and 4500 tons of displacement. The Sindh has been put temporarily upon the Brazil line; the two other steamers have been devoted to the Marseilles and Hong Kong line. At the close of 1870 the company had still three steamers in its yard in various stages of progress, viz., the Mei-Kong, the Senegal, and the Niger. These three vessels were not brought into service last year, in consequence of the company's working operations having been slackened upon the outbreak of the war; the disasters which befel the French arms in such quick succession soon also compelled the council of administration to postpone all its less advanced building operations, and to confine itself strictly to the maintenance of its floating plant. During the first half of last year the number of workmen maintained by the company at the Ciotat establishments was 3200, but this total was successively reduced to an average of from 1200 to 1300 men in October and November. The company was then called upon to put forth all the force and appliances at its disposal for the execution of orders for artillery to meet the pressing requirements of that branch of the French military service. Upon the receipt of these artillery orders, it became necessary for the council of administration to recruit the working staff of the company, but this recruiting could only be effected in the face of serious obstacles. It is only, in fact, within the last few months that the scarcity of labour experienced has been made good. The financial adjustment of the work executed for the Government last year may be expected, however, to increase the dividend for 1871.

With the close of the war, working operations were resumed at the Ciotat establishments as regards the three steamers left unfinished when the French soil was invaded by the victorious Germans. The result of the resumption of the company's ordinary works has been the sailing this autumn of the Mei-Kong on its first voyage to Hong Kong. It is expected that the Senegal will be ready for service towards the close of the year, while the Niger will also be able to put to sea in the spring of 1872. Including these three new steamers, the company will have a fleet of 67 ships representing an aggregate of 152,568 tons of displacement, and 22,315 horse power. The company has sold two of its steamers—the Thabor to the Japanese Government, and the Mitidjah to a Sicilian Steam Navigation Company. These sales were effected not only without loss to the company, but having regard to the amount redeemed of the original cost of these ships, a profit of some little importance remained. At the close of 1869, the value of the supplies and stores of all kinds collected by the company at Marseilles, La Ciotat, and Bordeaux, and at the agencies of the various lines stood at 919,646*l.*, while at the close of 1870 the corresponding total was only 503,728*l.* This diminution arose entirely in the services starting from Marseilles, and an explanation will be found in the temporary reductions introduced at the request of

the Government of the National Defence in the Mediterranean voyages of the company, and also in the temporary suspension of the fortnightly service to China which, by the terms of a convention of April 6, 1869, was inaugurated in the very month in which France commenced her fatal struggle with Germany, viz., in July, 1870.

The policy enforced by the State with regard to the company, as the war assumed a graver and graver phase for France, left the Atlantic service of the undertaking intact. In the Indian, Chinese, and Japanese seas the *itinéraire* was also left untouched but the number of voyages was reduced to one-half. In the Mediterranean the Algerian lines were maintained, but only a reduced service was continued on the principal lines of the company's eastern network. The Black Sea lines and the secondary lines of the Mediterranean were provisionally suppressed. The effect of the arrangements made was to reduce the aggregate obligatory voyages of the company during 1870 from 497,583 leagues to 471,916 leagues per annum. The aggregate length of the voyages actually made last year by the steamers of the company was, however, 523,387 leagues against 501,201 leagues in 1869. Deducting sundry accessory voyages made by vessels belonging to the company, the actual distance run last year was 508,631 leagues, showing an increase of 36,415 leagues as compared with 1869. Of this increase, 18,876 leagues were contributed by the Indo-China lines, 15,536 leagues by the Mediterranean lines, and 2003 leagues by the Brazilian and La Plata lines. The slight increase in the distance run on the last mentioned lines arose from the extension of the main line as far as Buenos Ayres. The increase in the distance run on the Indo-China lines arose, first, from an extension of the service; and, secondly, from voyages which had to be made to carry out the very reductions enforced by the Government of National Defence. The last mentioned circumstance also increased for the time the voyages made on the Mediterranean lines. The supplementary running of the year comprised ten voyages in July, 1870, between Marseilles, Algiers, Oran, and Stora in connexion with the movement of 15,000 men despatched from Algeria to the Army of the Rhine. The disturbances introduced into the company's business by the events of 1870, rendered it impossible to utilise advantageously the fleet of the undertaking, so that the average distance run by each steamer during the year was reduced to 7475 leagues. The maximum performance of any one steamer was achieved by the Sindh, which ran during the year 16,668 leagues in the Atlantic Ocean. The average speed realised was rather more than 10 knots per hour; it exceeded 10½ knots per hour on the principal China line, and 11½ knots per hour on the Brazilian and La Plata lines. So much for the Messageries Maritimes.

EMERY DISCS.

In January last (*vide* page 31 of our last volume) we directed attention to a new process for manufacturing artificial stone, invented by Mr. Frederick Ransome, and we pointed out the qualities by which the new material is distinguished from that with which Mr. Ransome's name has been so long and so honourably associated. More recently we have had to record the successful employment of the material for the construction of stone caissons for foundations, and we have now to speak of another entirely novel application of the same process, namely, for the construction of emery discs for grinding. As we explained in our former article, the new stone is composed of a mixture of ordinary sand, Portland cement, ground carbonate of lime, and some silica readily soluble in caustic soda at ordinary temperatures, these materials being combined by the aid of the silicate of soda prepared by his well-known process. The emery discs, which Mr. Ransome is now manufacturing, are composed of the same materials, except that the sand is replaced by emery, the result being a hard, compact material, possessing, in a very high degree, the qualities desirable in grinding discs, and capable, moreover, of being readily moulded during the process of manufacture to any required form.

We recently witnessed the performance of some of the discs on a saw-sharpening machine at the trial shop of Messrs. Allen Ransome and Co., of King's-road, Chelsea (who have made arrangements for the exclusive right to supply them for the purposes of sharpening saws, moulding cutters or other tools used in wood-working machinery), and we can speak highly of their cutting power. From the nature of the materials of which they are composed they are quite free from the fault of becoming clogged, as is the case with ordinary emery discs, and hence the emery they contain is always in the condition for making a clean cut. The new discs also appear to heat the metal they are cutting far less than those of the ordinary kind—a result, probably, of the cleanness of the cut—and this is an important matter when a heavy cut has to be taken at any one point. The new material also possesses the secondary advantage that its use is unattended by the disagreeable smell which is given off by ordinary emery discs when worked hard. We may add that some of the new discs have been employed for saw-sharpening for about three months at a saw-mill where they are in almost constant use, and they have been found to answer most satisfactorily, their cutting power proving materially greater than that of the ordinary discs.

So far we have only spoken of the new material—for such it practically is—as employed for saw sharpening or tool grinding; but it is evident that it has numerous other applications, and from its power of withstanding continuous work without softening or clogging it may be employed for a number of purposes, for which ordinary emery discs are unsuited. Amongst other things the "emery stone," as it may be termed, is about to be tried as a material for millstones for grinding flour, meal, &c., and as some stones for this purpose are now in progress of manufacture, and will shortly be set to work, we hope soon to be able to report the results. Meanwhile, we direct attention to the material as one of great promise, and one which forms another addition to the valuable artificial products for which the engineering world is indebted to Mr. Frederick Ransome.

MILLER'S CAST-IRON BOILERS.

At the meeting of the Institution of Mechanical Engineers held at Birmingham, yesterday week, the first paper read was a "Description of Miller's Cast-Iron Steam Boiler," by Mr. John Laybourne, of Newport, Monmouthshire. Of this paper the following is an abstract:

This boiler is composed of a series of cast-iron sections, of two patterns only, each of comparatively small size, so as to contain only a small quantity of water; those at the front end form a succession of arched tubes over the firegrate; and the rear sections consist each of five vertical tubes, united by a transverse horizontal tube at top and bottom, and placed with the tubes in each section opposite the spaces in the next. The whole of the sections of both patterns are bolted together by flanged joints at the bottom, each section having a communication through the bottom joints with the adjoining sections on either side; and a smaller wrought-iron pipe from the top of each section conveys the steam to a main steam-pipe, common to the whole boiler. All the joints are protected from the action of the fire, those at the bottom being below the fire level, while the joints at the top are in a chamber above the top of the flue. For the purpose of insuring efficient circulation of the water in all portions of the boiler, the arched sections at the fire end are cast with a longitudinal mid-feather in each leg, by which the ascending current of heated water on the inner side exposed to the fire is separated from the descending current of cooler water on the outer side; and in the rear sections the vertical tubes have an internal circulating tube placed within each, the heated water ascending through the outer annular space, and the cooler water descending within the circulating tube. All the sections of the boiler are left free to expand with the heat, the rear sections being attached together by only a single central joint, and the wrought-iron steam pipes at the top are long enough to allow of yielding to the requisite extent; the arched firebox sections are attached to the rest of the boiler on one side only, and are free to expand on the other side. No case has occurred of explosion with any of these boilers; and in the very few instances in which accidental fracture of the cast-iron has taken place, the only result has been that the water contained in the boiler has flowed out through the crack, without causing any damage beyond putting the fire out. By means of the flanged joints, a broken section in any part of the boiler can be readily removed, and replaced by a new one, without disturbing the rest of the sections, which are all duplicates of one another. Specimens were exhibited of fractured pieces taken from the boilers, illustrating the harmless nature of the cracks occurring in the cast-iron, and showing also that the quality of the metal remained, unimpaired after more than two years' working. The boilers are kept clean by blowing off at regular intervals, according to the quality of the feed water, and any deposit accumulating in the bottom portions is raked out whenever necessary, by taking off the bottom covers at the ends of the boiler. As the total quantity of water contained in the boiler is small, in proportion to the extent of heating surface, the water level is in some cases maintained at the required height by means of a self-acting feed apparatus, consisting of a hollow ball suspended from the arm of a lever controlling the feed cock; two pipes extending some distance horizontally communicate respectively with the top and bottom of the ball, the former terminating at the high water level inside the boiler, and the latter at a lower level. As soon as the water-level rises and covers the orifice of the upper pipe, the steam previously contained in the ball becomes condensed, and a vacuum is formed; and the ball then becoming filled with water entering from the boiler, depresses the lever, and shuts off the feed. When the water-level falls again below the orifice of the upper pipe, the water runs back out of the ball into the boiler, and a counterpoise upon the lever raises the ball and turns the feed on again. One of these cast-iron boilers has now been at work for two years and a half at the writer's works with complete success, and with an important economy in fuel. Several other boilers of the same construction are also in use at other works, and have proved entirely satisfactory. The particulars were given of a series of experiments made to test the evaporative power and economy of the boiler at the writer's works; and the average duty amounted to nearly 11 lb. of water evaporated from 100 deg. temperature of feed per pound of Ebbw Vale coal.

FOREIGN AND COLONIAL NOTES.

Ironstone in the Low Countries.—Some five years since traces of ironstone were observed at Venloo in the Low Countries. Since then it has been found at various points in the neighbourhood of the town. The minerals are despatched into Prussia. In the course of the past month 200 or 300 truck-loads have been forwarded.

Belgian Locomotives.—Contracts have been let in Belgium for nine goods engines, and it may be interesting to note the prices paid. The Tubize works took one lot of three at 2314*l.* per engine; the Evrard Railway Plant Company, another lot at 2317*l.* per engine; and the Couillet Company, another lot at 2325*l.* per engine. Each lot comprised three engines.

Intercolonial Railway.—The Intercolonial Railway Commissioners report that the total expenditure upon the 30 contracts entered into embracing the whole of the line amounted to 9,619,791 dols. This amount assumes the completion of the work at the prices agreed on, and it also includes payments upon abandoned contracts. The further sum of 921,020 dols. must be added for the purchase of the Eastern Extension Railway forming a link of the Intercolonial. The purchase of rolling stock and steel rails and the laying of the latter will involve the only remaining serious expenditure. It is expected that the whole work will be carried out for about 15,000,000 dols.

Quebec a Naval Station.—It is said to be the intention of the Imperial Government to make Quebec a naval station and to place heavy armaments in the new fortifications at Levis. It is also hinted that a garrison will be maintained at Quebec as an auxiliary to the naval station.

The Pacific Railroad.—The earnings of the Central Pacific Divison of the Pacific Railroad amounted in September to 1,032,800 dollars as compared with 787,183 dollars in September, 1870. The aggregate earnings of the division in the nine months ending September 30th this year amounted to 6,952,352 dollars, against 5,805,464 dollars in the corresponding period of 1870, showing the large increase of 1,147,888 dollars.

Railways in New Brunswick.—The necessary capital has been raised in Great Britain for the construction of the Quebec and New Brunswick Railway from Rivière du Loup to Fredericton. Contracts are expected to be given out at once, and the work is to be pushed on with the least possible delay. The line will form the shortest route through British territory from Quebec to St. John and Halifax, so that it is expected that it will prove of considerable benefit not only to New Brunswick, but to all sections of the Dominion of Canada.

Belgian Coal.—The exports of coal from Belgium in the first seven months of this year declined to 1,690,000 tons, as compared with 2,172,000 tons in the corresponding period of 1870, showing a decrease this year of 382,000 tons. This decrease, which is attributable, of course, to the disturbed state of the Continent, will probably be much reduced by the time that the figures for the whole of 1871 come to be made up and compared with those for the whole of 1870, as there has been a decided revival in affairs since July, while great depression prevailed in the autumn of 1870.

The Upper Ohio Valley.—This region is said to be rich in coal and iron. South of Huntington there are inexhaustible supplies of cannel and splint coal, the latter of such a laminated structure that it can be used without coking in the working of iron ore. Boyd, Carter, and Rowan counties in Kentucky have large supplies of excellent coal. The Lexington and Big Sandy Railroad, which joins the Chesapeake and Ohio at the Big Sandy, and is to run 120 miles to Lexington, passes through a region known to be rich in both coal and iron deposits which have hitherto been useless for lack of the means of transportation.

MM. de Dorlodot Frères.—The extensive establishments of MM. de Dorlodot Frères have been transferred to a joint stock company. The principal members of this company are MM. Eugène de Dorlodot, Leon de Dorlodot, Charles Evrard (director of one of the Belgian railway plant companies), Vander Stichelen, &c. The last named gentleman has been honourably known in his time in the Belgian official world.

Coal in Prussia.—The quantity of coal raised in Prussia last year was estimated at 23,816,237 tons obtained by 107,782 workmen, while in 1869 the corresponding production was 23,761,044 tons. The number of workmen employed in 1869 was, however, 111,325, the great war of last year having told upon Prussian coal mining.

Australian Steam Navigation.—The Australian Steam Company has decided on transmitting to England orders for the building of two screw steamers for the purpose of more effectually carrying out the Californian mail service. The boats are to be spar decked and of 1500 tons burthen; they are to be fitted with compound engines and a speed of 12 knots per hour is to be guaranteed.

The Russian Navy.—Within the last eight years no fewer

than 24 ironclads have been added to the Russian navy. Two ironclad turret ships (the Lazareff and the Admiral Greig) have been launched since the commencement of the present year, and two others (the Speridoff and the Tchithagoff) are all but completed. It is stated that large stores of iron and other necessary materials are about to be dispatched to Nikolaieff for the construction of new ironclads.

Brasilian Telegraphy.—Continued progress is being made with the development of telegraphic communication in Brasil. A line between Paranagua and Coritiba has been finished.

Defences of Cronstadt.—The Russian Minister of War has made personal inspection of the defences of Cronstadt, and signified his approval of their condition. A new battery has recently been constructed; it is armed with six movable iron turrets mounted with guns of the heaviest calibre.

Indian Railways.—The Indian Government has issued orders for the completion of the State Railway from Kotree to Surkur in Sinde without delay. Major Bonus has been appointed to take charge of the work. The aggregate earnings of the Indian railways—that is, the guaranteed Indian railways—in the first half of 1871 amounted to 3,276,186*l.*, against 3,472,452*l.* during the corresponding period of 1870, showing a falling-off this year of 196,314*l.*

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Colliery Extension near Sheffield.—Messrs. J. Rhodes and Sons, who are already large colliery proprietors in the district, are now sinking a new colliery at Unstone, near Sheffield. This pit, the first sod of which was cut in March last, is beginning to assume definite proportions. Two shafts are being sunk, one of which has reached a depth of 85 yards, and the other about 45 yards, both through a very hard rock. Below this rock the measures have been found so wet that sinking operations were perforce suspended pending the erection of a Cornish pumping engine of about 200 horse power, which, when fixed, will lift about 1000 gallons of water per minute. A branch line about half a mile in length will be made to connect the colliery with the Midland Railway.

Bradford Sewage Works.—The Bradford Town Council have accepted the tender of Mr. Archibald Neill, of Bradford, for the execution of the several works required for the defecation of the sewage of that borough. The amount of the tender for the works is 12,700*l.*, with 500*l.* additional for stationary engines, cranes, &c., bringing the total up to 13,200*l.* It is stated that this amount is something over 3000*l.* in excess of the estimated cost as given by the representatives of the Peat Engineering and Sewage Filtration Company, who have entered into an agreement with the company to defecate the sewage of the borough.

Manufacturers and the Premier Baronet.—The Pendleton Iron Company, contemplating an extension of their business, had, it is stated, selected a site for new works at Ashcroft, near Gainsborough, North Lincolnshire, at which it was intended to employ some 2000 hands. The site chosen is about 40 acres in extent, on the banks of the river Trent, and near the junction of the Great Northern and Manchester, Sheffield, and Lincolnshire Railway Companies' lines. The owners of nearly three-fourths of the land agreed to sell, but the owner of the remaining portion, Sir H. Bacon, who is premier baronet of England, has positively decided not to sell a single yard. The scheme consequently remains in abeyance.

Opening of the New North Bridge at Halifax.—This very fine piece of work was opened on Wednesday last with considerable *éclat*. The structure has cost 46,149*l.*, and consists of two spans of iron resting on a central stone pier. It is 150 ft. in length, and 60 ft. in width, a very great improvement on the old bridge. The town was *en fête* the whole of the day, and the streets were decorated with a profusion of banners and bunting. The Right Hon. James Stansfield, M.P., was present, and a large number of county gentlemen. A banquet took place in the Town Hall in the evening, Mr. Stansfield responding to the toast of the West Riding and the borough members.

Sheffield and the "Goux" System.—At a meeting of the Health Committee of the Sheffield Town Council, held on October 26, Mr. F. N. Target, C.E., managing director of the Sanitary Improvement and Manure Manufacturing Company (Limited), attended on behalf of that Company, who are the proprietors of the Goux system of absorbent closets, and explained the method of carrying out and working the system. After a discussion as to whether it was applicable to a part of Sheffield, a sub-committee was appointed to select a district of the town for trials.

Tramways for Sheffield.—A special meeting of the Sheffield Town Council was held on Monday to consider the desirability of constructing certain tramways in that borough. The borough surveyor, Mr. S. F. Holmes, in his report which was read at the meeting, recommended one line of route as the best to be laid down at first. This route would be from the Norfolk Market Hall, in the centre of the town, along Wainsgate. The Wicker, &c., to Brightside and Carbrook. The whole of the route is not yet pitched with Mount Sorrel sets, and the cost of so pitching the whole route is estimated at 17,300*l.* The estimate for the construction of the tramway itself is 21,500*l.* It was resolved that application be made by the council to the Board of Trade under the "Tramway" Act of 1870 for the necessary authority to construct the tramway, the requisite notices to be given as required by the Board of Trade.

The Nine Hours' Movement at Sheffield.—During the past week or ten days the men engaged in the various branches of the engineering trades at Sheffield have quietly secured a bloodless victory by obtaining in the great majority of cases the adoption of the nine hours' system. Having profited by the experience of the Newcastle men, the Sheffield engineers formed a "Nine Hours' League" before giving notice. They then issued a circular asking for their object, and they have since received replies from most of the firms intimating their willingness to meet a deputation from the men in order to arrange matters. So far there is no prospect of any strike arising. The nine hours' system has also been adopted at Lincoln, Gainsboro', Grantham, and other towns.

The Proposed Railway from Nottingham (Great Northern) to the Manchester, Sheffield, and Lincolnshire Railway.—It is understood that the proposed Great Northern line will come *viâ* Mansfield from Nottingham, near the ponds at the back of Hardwick Park, by Hardstaff Common and Temple Normanton, down the valley to Spital, thence up the valley of the Hipper towards Lower Brampton, as far as West Bars, where it is proposed to locate the station for Chesterfield. Leaving West Bars, it is proposed to drive a tunnel under Pothouse-lane and Trinity Church till reaching the wharf, where a junction will be effected with the line promoted by the Manchester, Sheffield, and Lincolnshire Railway Company. This latter line is intended to run along the present canal, cutting off the numerous angles, to the Sheffield main line near the Kiveton Park Station. The canal is now practically useless, as the tunnel has been "let in" by the workings of the numerous adjacent collieries. The Midland will, of course, oppose these schemes with all their force, seeing that they penetrate into the heart of the district hitherto monopolised by that company.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Since last report there has been a good deal of firmness in the local pig iron market. The highest prices last Wednesday were 62s. 9d. cash, and 63s. one month; the next day was the usual autumnal Sacramental Fast Day, and therefore no market was held; on Friday the market was strong, and prices advanced 6d. per ton. There was a further advance of 1s. per ton on Monday; yesterday's prices showed a little downward reaction, but the market has again been very strong to-day, the prices being 63s. 10½d. to 64s. 4½d. cash, and 64s. 3d. to 64s. 9d. a month, closing, sellers a shade lower than the highest. Makers' quotations have again been raised. Coltness No. 1 is away up at 75s., Gartsherrie at 74s., and the other special brands at proportionate rates. The shipments of iron from Scotch ports have again been very good. The Carron Company are building three new furnaces, which are expected to be ready this year. Mr. Ferrie's new furnace at Calderbank, which will be 92 ft. high, is rapidly approaching completion. Messrs. William Baird and Company are about to blow in some furnaces in Ayrshire. There are already four in blast at Govan Iron Works, and another one is nearly ready for blowing in. One is being relined at Summerlee. It is likely, however, that one will soon be put out of blast at Gladsmuir Iron Works, East Lothian.

Contract for the New Harbour Works at Dundee.—At a meeting of the Works Committee of the Dundee Harbour Trustees yesterday, the offer of Messrs. A. and K. M'Donald and Co., Glasgow, for the construction of a graving dock of 500 ft. in length, opening both into Victoria and Camperdown Docks, was accepted for the sum of 37,740*l.*, and for the completion of Victoria Dock 44,240*l.*—making a total of 81,980*l.* It may be mentioned that Messrs. Ower and Cunningham, the local engineers, estimated in December last that these works would cost 84,000*l.*, so that the offers now accepted are slightly within the estimate. It is understood that the works are to be finished within two years. Six months are allowed for the exclusion of the water from Victoria Dock, and the remaining eighteen months for the completion of both the graving and Victoria Dock after the contract is signed.

The Edinburgh Tramways—Official Inspection.—On Monday morning Colonel Yolland, the Government Inspector, proceeded on behalf of the Board of Trade, to inspect the lines of tramways already laid. He walked over the whole routes and made a most minute inspection of the works, spending a considerable time in examining the various points and crossings. At the conclusion of the inspection, Colonel Yolland expressed himself highly satisfied with the construction and safety of the works. The intention is now to open for traffic on Monday next.

Greenock Gas Works—Ironwork Contract.—The ironwork and general engineering work required in connexion with the new gas works about to be erected in Greenock will be executed by Messrs. Hanna, Donald, and Wilson, of Paisley. Their contract price is 36,000*l.*

Shipment of Iron Vessels to Rio Grande.—The Galatea, which lately left the Clyde for Rio Grande do Sul had on board an iron barge, weighing 6 tons 6 cwt., and valued at 230*l.*; an iron paddle steamer (complete), valued at 2255*l.*; an iron paddle yacht (complete), weighing 3 tons 10 cwt., and valued at 460*l.*, together with steam engines to the value of 110*l.*

Dhubeartach Lighthouse.—The new lighthouse which has been building for some time past on Dhubeartach Rock, about 15 miles west of the island of Colonsay, is now almost finished.

Inspection of the New Harbour Works at Aberdeen.—A few days ago the Harbour Commissioners paid a visit of inspection to the diversion of the Dee and the new south Breakwater. It was found that the contractor, Mr. Grainger, had succeeded in shutting out the water, and was emptying the new channel at the rate of 3000 gallons per minute. He has excavated 860,000 cubic yards, and has only 90,000 to do. In nine days the water will be pumped out, and it is fully expected that the river will be occupying its new course within the stipulated time, which will not expire for two or three months. The breakwater is to be 1200 ft. long, 450 ft. being already completed. This has taken 12,500 cubic feet of concrete, upwards of 10,000 ft. having been laid down in mass. 12,000 cubic feet of blocks are stored for building. The works altogether were considered in a gratifying condition.

The Dundee Water Scheme.—For some weeks the Dundee Water Commissioners have been at loggerheads with respect to the direct and indirect routes from Lintrathen, the source of the new supply, to Dundee. Mr. Bateman, who was the consulting engineer in reference to the undertaking was in favour of the indirect route, and owing to his reply to some letter sent to him on the subject his appointment to the office was annulled at a meeting of the commissioners held yesterday, and it was resolved that Mr. Stewart and Mr. James Leslie, of Edinburgh, should be engaged to make the necessary surveys and carry through the works.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was an excellent attendance on 'Change at Middlesbrough. A fair amount of business was transacted at the prices which have been quoted for several weeks, and the market closed firm. So great is the demand for pig iron that some of the leading firms in Cleveland are making as much as 52s. 6d. for No. 3 for immediate delivery, while orders are regularly being booked at 51s. for No. 3 for delivery next year. To all parts shipments are brisk.

The New Works on Tees-side.—Rapid progress is being made with the blast furnaces and finished iron works which are now being erected on the banks of the Tees.

The Nine Hours' Movement at Middlesbrough.—On Saturday a mass meeting of men employed in the engineering trade was held at Middlesbrough. About 2000 persons were present. After several speeches had been made on the subject of the nine hours, it was resolved "that no other terms of overtime be accepted with the nine hours' movement but the old established terms worked under each firm previously, this being the same as the Sunderland arrangement." We trust that the question may be settled in a friendly way.

NOTES FROM THE SOUTH-WEST.

Labour in Wales.—It is stated that one large company producing upwards of 2000 tons of finished iron per week declines to take time contracts except on the understanding that any strike of workmen shall release the management from the obligation to complete the contract within the period specified.

Abercarn Collieries.—A change has taken place in the management of these collieries. Mr. W. Needham, of Beaufort, has succeeded Mr. Llewellyn. Mr. Needham was for several years principal viewer at Beaufort.

Devonport Dockyard.—Dissatisfaction has been occasioned in Devonport dockyard by the introduction of a new system of overtime. Hitherto overtime has always been paid for over and above regular wages, but recently a number of smiths, who have been on extra time for the completion of urgent work, were informed that this could not be paid for in cash, but that they were not to resume work for two days, so as to adjust matters.

Fishguard.—Some discussion has recently taken place with reference to a proposed revival of a project for the construction of a railway from Clarkeston-road to Fishguard, and for the establishment of a line of steamers between that port and Wexford. Such a line would, it is stated, reduce the distance to Ireland by 40 miles as compared with Milford.

Launch of the Thetis.—Yesterday week the Thetis, screw sloop of war, was launched at Devonport dockyard. She is the first of her class, and is built on the composite principle. She will carry 14 guns—six 64-pounders on each side, and one heavy gun at stem and stern.

Briton Ferry Iron Works.—A new rolling mill is to be added to the Briton Ferry Iron Works. The work has been commenced, and is being pushed forward with all despatch under the superintendence of the chief mechanic, Mr. E. Roberts. The Briton Ferry Iron Works Company is about to commence the manufacture of wrought-iron railway chairs and sleepers on a principle embodied in a Belgian patent. The contract for the machinery required has been intrusted to Messrs. Davies and Sons, of the Briton Ferry Foundry.

Tunnelling the Severn.—Two schemes are before the public for tunnelling the Severn, one having been brought forward by Mr. Fulton and the other by Mr. Richardson. Mr. Fulton proposes to burrow under the river near Lydney, while Mr. Richardson has selected a point known as New Passage as the scene of his contemplated operations. Mr. Leonard Bruton, late secretary of the Bristol and South Wales Union Railway, has announced that the directors of the Great Western will support the new passage scheme. The cost of the works, including approaches and branch lines, is estimated at 750,000*l.* in round figures.

MR. JAMES EASTON.—With much regret we have to announce the death of Mr. James Easton, which event occurred on the 25th ult. Mr. Easton was born in 1796, at Bradford, near Taunton, his father being Josiah Easton, a well-known land agent and surveyor. In 1822 Mr. Easton came to London and introduced the hydraulic ram, the patent of which he had purchased from Montgolfier. He was afterwards engaged on several important railway surveys, subsequently to which he directed his attention to mechanical engineering, and in 1827 established the well-known firm of Easton and Amos, now Easton and Anderson. The late Mr. Easton was essentially one of the pioneers of the engineering profession, and during his life he carried out many substantial works. Our present remarks upon the deceased gentleman are purposely brief, as we are preparing a careful notice of his eminently useful and practical life.

NARROW GAUGE RAILWAYS IN RUSSIA.

To the Editor of Engineering.

Sir,—The question of cheap railroads, represented by the narrow gauge system, has lately occupied the attention of engineers almost throughout the world, and I find that the Imperial Livny narrow gauge railroad has attracted special attention. This line was constructed by the Russian Government with the sole object of studying the narrow gauge system, the latest inventions and improvements were adapted to it, and trials of different kinds made by sundry commissions of distinguished engineers; therefore the Livny Railroad may be considered as a model of the narrow gauge system. Supposing that correct information concerning this line would not be without interest to the engineers of your country, I, with this, send you a short description of the line, and the results of some experiments on its working, hoping that you will not refuse to publish it in your esteemed periodical.

A special commission, by appointment of the Imperial Russian Government, visited in 1869 the narrow gauge railroads of Europe, namely, those of Festiniog, in Wales, and the line from Antwerp to Ghent, in Belgium. This commission was in favour of the 3 ft. gauge, but a general commission, named, in order to study the narrow gauge question in regard to its application to Russia, adopted the 3 ft. 6 in. gauge, which is for the present introduced into this country.

As yet there are in Russia but two narrow gauge railways at work; these are the Livny Railroad, built by the Imperial Government, and the Novgorod line, constructed by a private company. A third line from Vologda to Jaroslaw (133 miles long) is now being constructed, and is expected to be finished by the end of the year.

The Novgorod Railway (55½ miles long) is constructed in a flat country, and being principally intended for passenger traffic, is supplied with a light rolling stock, built on the same principles as those generally used on all the railroads of Europe.

The engines on this line, built on the American system, are only of 12 tons. There are no curves on the line with a smaller radius than 16½ chains. The steepest gradient is of 1 in 142; of these there are only two instances measuring together about three-quarters of a mile.

The cost of construction of this line amounted to 27,000 paper roubles per mile. This line having begun to work only since the month of May, and to vie with a company of river steam navigation, existing for many years, has as yet been scarcely able to give any dividend.

The Imperial Livny narrow gauge railroad (38.15 miles long) is situated in Central Russia, in the Government of Orel. It joins at the station Virchovie a broad gauge line, which traverses Russia from Tzaritzin on the Volga, to Riga on the Baltic. The building of the Livny line was commenced on the 1st of May, 1870, and was finished on the 16th of April, 1871. The country which this line passes through presented some serious difficulties for railway building, occasioned by the deep ravines which cut the country in all directions. The most difficult part of this line was the crossing of the valley of the river Lionboosha, near the station, Russtri Brod, about the middle of the line. There is a difference of about 300 ft. between the bottom of this valley and the neighbouring heights. The difficulties of this part of the line were overcome by means of sharp curves with minimum radius of about 10 chains; gradients from $\frac{1}{100}$ to $\frac{1}{70}$ in 14½ miles; the length of the 1 in 80 gradients being 5½ miles in one direction, and 4 miles in the other.

There are 55 curves on the line, of which 25 are to the left and 30 to the right; the whole length of the curves is 5½ miles.

There are five stations on this line, all the buildings being built of timber, except the shops and engine sheds, which are of brick. There are 52 bridges and viaducts on this line; of these only 4 bridges over roads and footpaths, and 17 culverts are of stonework, the rest are constructed of timber. One viaduct is 80 ft. high and 504 ft. long; four bridges from 40 to 47 ft. high and 126 ft. long; one bridge 35 ft. high and 112 ft. long, and two from 25 to 35 ft. high and 105 ft. long.

The surface of the embankment is 14 ft. broad; the ballast has a width of 8 ft., and is 1 ft. 4 in. thick. The sleepers are 6 ft. 5 in. long; the rails 20 in. long by 4 in. high, being 45 lb. to the yard, and are laid upon nine sleepers.

Each station is supplied with a permanent steam pump, which feeds the station tanks with water, conducted through 4 in. pipes from two rivers and three reservoirs; the whole length of the pipes is 12,250 ft. The rolling stock consists of 7 engines, of which 2 six-wheeled tender engines of the weight of 17 tons (empty), and 5 twelve-wheeled tank engines on the Fairlie system; 17 passenger carriages, with places for 316 passengers. These carriages have a passage through the middle, by which a circulation is possible from one end of the train to the other. The number of goods wagons is 266. The weight and carrying capacity of the wagons is as follows:

					Net weight.			
	Tons.	cwt.	qrs.	lb.	Tons.	cwt.	qrs.	lb.
Platform ...	1	13	3	0	5	19	1	12
Open carriage	1	17	0	20	5	16	0	16
Closed	2	1	3	28	5	9	2	24
Brake van ...	3	19	3	0	4	0	2	14

The diameter of the wheels is 2 ft. 5 in. The Fairlie double bogie engines are on twelve wheels, divided in two groups of three pair of coupled wheels 3 ft. 3 in. in diameter. The cylinders are 15 in. diameter; the diameter of the boiler 3 ft. 6 in. The pressure of steam is regulated to 140 lb., but the engines are generally worked only with 125 lb. of steam. The weight of the engine is 35½ tons empty, and 46 tons in working order. A Fairlie engine running with a goods train at a rate of 10 miles an hour uses 3.03 cubic feet of wood fuel per mile. There is room on the engine for 320 cubic feet of wood fuel, 193 cubic feet of water in the tanks, and 130 cubic feet in the boiler. An ordinary goods train consists of 42 to 50 wagons; gross weight, 300 to 365 tons, of which the net weight in working order is from 210 to 250 tons. The heaviest train drawn up to this time by the Fairlie engine on the Livny line was of 400 tons gross weight, the net weight being 288 tons; the train composed of 61 goods wagons, exclusive of the engine, measured 896 ft.

The construction of the Livny line has cost about 38,250 paper roubles per mile, of which price about 10,500 paper roubles per mile were employed for the purchase of the rolling stock.

The rails were manufactured at the Blaina Works. The Fairlie engines were built by Sharpe and Stuart, in Manchester; the tender engines by Kitson and Co., in Leeds. The carriages of goods wagons were furnished by a Belgian company in Brussels. The rolling stock was constructed after plans made by Mr. Schuberszky, Russian engineer, member of the Board of Managers of the Livny Railway, who also superintended its manufacture at the works.

Mr. C. P. Sandberg, consulting engineer in London, was intrusted by the Imperial Government with the inspection and reception of the rails at the Blaina Works.

The Livny line having been worked only five months, it is difficult as yet to estimate with precision the advantages of this line, compared with a broad gauge railroad. Undoubtedly the admission of sharp curves and gradients of $\frac{1}{70}$ make a considerable economy in the earthworks and surface of land occupied by the railroad, the lighter weight and smaller dimensions of rails, sleepers, bridges, and rolling stock producing an economy in the construction of a narrow gauge railway certainly not less than 20 per cent. than any broad gauge railway built on the most economical principles. The favourable proportions of paying weight to the gross weight (on an average from 0.67 to 0.75), and the slight wear which the Fairlie engines and light wagons occasion to the rails are certainly conditions which will greatly contribute to the economy of the working of narrow gauge railways.

I have the honour to be, Sir, your obedient Servant,

St. Petersbug, Oct. 25, 1871. L. K.

SALT MAKING.

Two years ago we had the opportunity of visiting the Salt Works of Messrs. Hamer and Davis, at Wincham, near Northwich, and were much gratified to notice what appeared to be some decided improvement in the salt boiling and evaporating process. Letters patent had been taken out for the machinery invented, to effect the work which has usually to be done by hand labour under peculiar disadvantageous circumstances from the heat and steam in which the salt boilers have to be enveloped during the process of "drawing the pans." The firm have had three pans at work on the improved principle since, and the members of the trade have been allowed ample opportunity of inspecting the process. For the information of those who have not seen it, the following extract from our previous description will give an idea of the machinery and its operations: "The salt is taken out of the pans by steam power instead of by men, and continued night and day alike. The salt being taken out so regularly prevents the formation of scales, so that the pans need less hammering, and therefore less twisting of the plates, and also obviates the leakage and consequent destruction of the brickwork and fitting up of the flues, as in the old method. All these improvements combined, more salt is made from the same quantity of fuel, and in less time, from the same dimension of pans. The mode in which this work is performed is by having a railway up each side of the pan, or by making the pan side into a railway, and having a carriage across the pan, constructed with a shaft through the centre, to which rakes are attached by one end; the other end of the rakes travel on the bottom of the pan. The carriage has a flanged pulley or wheel on each end, the same as a railway carriage, and travels from front to back of the pan, with the rakes that cover the whole width of the pan. The machinery is so arranged that the carriage is drawn backward and forward by wire ropes. When the rakes are at the front end of the pan, and begin to be drawn towards the back, they take the salt as it is made with them at the rate of about 20 ft. per minute until they arrive at the foot of an incline, up which the rakes travel, and on arriving at the top, the salt drops into carts standing to receive it. The travel of the rakes at the foot of the incline changes, the speed being reduced to about 2 ft. per minute while ascending the incline, so that the brine runs from the salt down into the pan, instead of in the old way, on to the hurdles to be wasted, and it is quite hot when it gets into the pan again. The rakes having dropped the salt into the carts, the machinery is so arranged that the carriage is raised on one side, lifting the rakes up, and being held up by a leg or catch on each end of the carriage, a return motion takes place and the carriage and rakes go back to the front of the pan, at which place the catches or legs are set at liberty, and the rakes go down into the pan and commence another journey."

During the period which has elapsed since the above was written, other improvements have been added at the works, a brief description of which may prove interesting. The salt on being taken from the pans as described instead of being put into carts and taken into the store by men, is now put on to a travelling carriage or elevator, and carried up into the roof of the storehouse, where it is tipped so as to fill the store on all sides equally, by which the salt is kept cleaner and in better condition from not having to be handled until loaded into boats or railway trucks. A further improvement has now been effected at these works in the manufacture of salt of any description. The firm have obtained a patent for supplying the evaporating pans with heated brine, instead of allowing it to flow into the pans in its natural cold state. The advantages of this improvement are that it enables the firemen to keep the pans at a more equable temperature with less labour and consequently with less damage to the pans and furnaces. This contrivance is very neatly and ingeniously carried out by throwing the exhaust steam from the engine or from the steam boiler into a large tube, this tube having a second one through its centre which contains the brine on its passage to the evaporating pans, thereby heating the brine and at the same time condensing the steam. This condensed steam then becomes very hot water, which is used to feed the steam engine boiler, and thus a very small quantity of fresh water is needed for the boiler, and considerable less mud and scale is generated, an important desideratum where the water supply is very impure. These improvements appear to be working very satisfactorily, and from the information derived at a second visit to the works last week, we should judge that an inspection of the processes is very desirable on the part of those interested in the trade. Having had experience in the difficulties attending the production of machinery in another branch we can readily appreciate those which Mr. Hamer has had to encounter in bringing his contrivances to such a successful issue as they have already attained, and can easily understand that in fitting up other pans on the principle described, the plans may be modified and simplified a good deal in their construction.

In the above the impressions are given of a casual visit to the salt works, and the point which suggests itself as most important, is the desirability of devising means for saving the men and, in some cases, women from the degrading occupation to which they are subjected in salt boiling. We hope that what is described above may have this tendency.—*Northwich and Winsford Guardian.*

Canadian Oil Wells Company.—The directors of this company have received a satisfactory report from Mr. J. F. Dalrymple Hay, C.E., with respect to the properties of the undertaking.

The Institution of Civil Engineers.—The members of this incorporated Society have been informed by circular issued during the current week, that the Ordinary Meetings, for the reading and discussion of Original Communications on subjects connected with Mechanical Science, more particularly those which constitute the profession of a civil engineer, will be resumed on Tuesday the 14th of November. The members have been reminded of the obligation entered into on election, that they would endeavour to the utmost of their power, to promote the public and scientific objects contemplated in the Royal Charter of incorporation, by presenting papers tending to advance professional knowledge, by frequent attendance at the meetings and occasional participation in the discussions, and by contributing copies of reports and treatises to the library. The deaths have been recorded during the last three months, when the Institution has been in recess, of F. M. Sir John Burgoyne, G.C.B., &c., honorary member; of Messrs. Joseph Hamilton Beattie, John George Blackhume, Robert Benson Dockray, Albinus Martin, and Josiah Parkes, members; and of Messrs. Arthur Field, Edward Mosely Perkins, and Henry Beadon Rotton, associates. The numbers of the several classes now on the register are 14 honorary members, 725 members, and 1056 associates, with a class of 205 students attached, making together of all grades 2000.

Hydraulic Bending Machine for Pembroke Dockyard.—On Saturday evening a very large casting was made at the works at Cubitt Town of Messrs. Westwood, Baillie, and Co., for the cross-head of a very large and powerful hydraulic machine for bending iron armour-plates in Pembroke Dockyard. The casting weighs in the rough 28 tons 9 cwt., and the metal was melted in two cupolas. The other parts of the press have already been executed, and the present portion when finished will complete this very fine machine. The bed-plate is of cast iron, sufficient in strength to stand the test of 4000 tons. The four columns are forged from the best scrap iron, and as turned with the screw-thread for the nuts to screw over are 18 in. in diameter. The distance between them will be 7 ft. The cross-head itself is 11 ft. 10 in. by 5 ft., and 4 ft. 8 in. deep, with three cores running through it, and will be supported by four nuts, 21 in. diameter and 10 in. thick, so that it can be raised or lowered to any required height. The cylinder is 40 in. in internal diameter, and its walls 7½ in. in total thickness. It is formed of a thin inner ring of wrought iron, surrounded with thick rings of cast steel. It will be fitted with a cast-iron ram of the like diameter, and there will be a small gun-metal hydraulic attached to the large one to move the cylinder from one side to the other. The centre ring of the great cylinder is formed of a wrought-iron plate, 4 ft. 10 in. square and 5 in. thick projecting about half an inch beyond the outer rings, so as to form a bearing for the guide plate to prevent it from canting. The pumps are four in number, of gun-metal, with very strong gear. Two are of 1 in., and two are of 2½ in. diameter, being respectively worked from a strong eccentric shaft, and so arranged that only one pump exerts pressure on the ram at the same time. They will be driven by a spur wheel and pinion, the wheel being fitted on the eccentric shaft, and the pinion and a small fly-wheel on the intermediate shaft, on which are fitted the fast and loose driving pulleys. The diameter of these pulleys is 18 in., and the speed at which they will run will be 200 revolutions per minute. The weight of the whole machine will be about 80 tons.—*Standard.*

DYER'S RAIL GAUGE.

FIG. 1

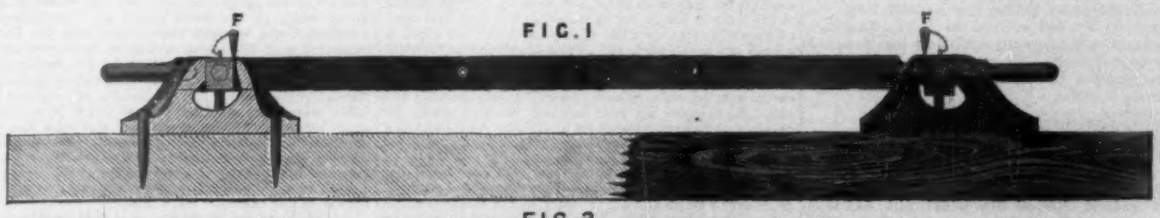


FIG. 2

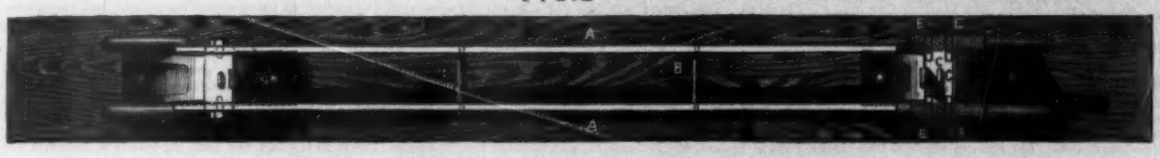
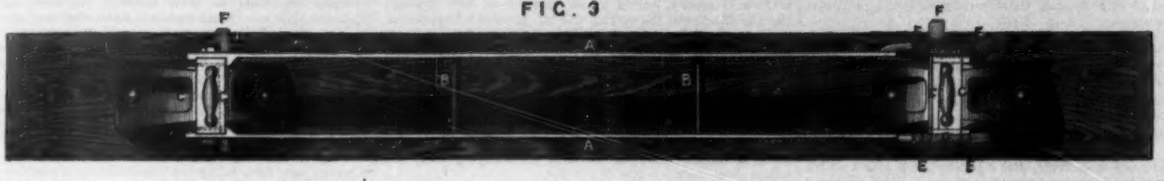


FIG. 3



The object of this very useful instrument, of which we annex engravings, is to facilitate the operation of fixing chairs on their sleepers when in store, and thus to overcome the objections to the present method of adjusting, bolting, or spiking chairs on their sleepers during the time of relaying, and in the construction of new lines.

The gauge consists of two bars of iron or steel, A, braced by a couple of centre stays, B, and having two wrought-iron distance blocks, C, one being securely fixed between the bars at one end, and the other resting on screw guides, D, at the other end, for the purpose of allowing longitudinal adjustment to suit the different sections of rails and chairs, and also for slightly varying the gauge for sharp curves. The nuts, E, by which the movable block is adjusted, are so formed as to always cover and protect the regulating screws. The two small steel wedges, F, are used to hold the chairs, G, securely during the time of boring, fixing, bolting, or spiking.

The distinctive feature of this arrangement is that of securely holding the chairs on the sleepers in a position perfectly parallel to each other during the time of boring and spiking, and by the application of the wedges to the inner or outer jaws as required, the chairs are held firmly and true to the distance or gauge blocks, so that when the sleepers are laid, the track of the road is certain to be of one uniform gauge.

Mr. Dyer, locomotive engineer, Bristol, who designed the gauge under notice, claims a saving of over 30 percent. in labour and general economy by its use, equal to 15*l.* per mile, and a facility in relaying straight or curved lines which cannot be obtained by any other known method.

The mode of fixing the chairs is so simple that it can be done with unskilled labour. The gauge has been introduced only a few months, but during that time the Midland Railway Company has applied it to the relaying of eight miles of mixed gauge lines at Bristol, with a saving of over 30 per cent., and the line, as to gauge, is admitted by all who have seen it to be much better laid than by the old method.

The Great Western, Great Northern, and London and South-Western Railway Companies have taken up the invention, and there seems a good prospect of its being brought into general use.

NOTES FROM GERMANY.

BERLIN, October 30, 1871.

AUSTRIAN RAILWAYS.

A new length of the Charles-Lewis Railway has just been opened for traffic to join up with the Russian system, but the Russian junction line to the Odessa Railway *viâ* Wolocsyak is in a wretched state. A sentiment of anxiety takes possession of the traveller using this line.

The Hungarian Mihályi-Hourona section of the Hungarian-Galician Railway is about to be officially inspected, and it will be opened as soon as the North-Eastern Railway is ready with the Szerems-Ujhely junction to the Theis Railway. The Hungarian-Galician Company has had no small difficulties to encounter with regard to language. All public documents, &c., relating to the line have had to be prepared in German, in Hungarian, and in Polish.

The Hungarian State Railway Company has just published an excellent and elaborate report for 1870. It is the first essay of the kind that has been printed in the Hungarian language. The business of the line is graphically represented in a very complete manner. The following figures sum up the particulars of receipts and expenses:

Line.	Receipts.	Expenses.
	francs	francs
Pesth—Salgo-Trargan	3,592,696	1,693,120
Hatvan-Miskolcs	1,531,137	334,827
La Kany Agram	429,976	533,748

The deficit on the last-named section will result in an inquiry into certain alleged abuses and malpractices, and it is said that the directors of the Hungarian Credit Company are intending to sell the line.

The Dux-Bodenbach Railway was opened for traffic on the 28th of last September, after the necessary official inspection. To those who are acquainted with the district it is needless to point out the advantage of the line to the north of Bohemia, especially with reference to the constantly increasing coal traffic. Every one who has watched the development of the mining industries of this country between the rich deposits in the central chain of mountains and the Elbe will at once understand the importance of the new railway. Before it was opened the Aussig-Teplitzlaie was the only one available for carrying mineral from the Dux basin to the Elbe. The new railway runs through the finest part of Bohemia, and close to historical Kulm. It was constructed under great difficulties, especially near Bodenbach for a length of 24 miles, the district being very unfavourable for railway construction. From the Klein Kahn station to the Bodenbach station the gradient is 1 in 50. Much bog land and sliding ground was also traversed. The highest point of the line is at the Klein Kahn station, 1200 ft. above the sea, and 580 ft. above the Dux station. Besides the two termini the most important place on the line is Teplitz, a famous and growing watering place. The station at this place is near the town in a charming country. Altogether there are eleven stations on the railway. The execution of the whole of the work is first-class, and the engines and rolling stock are of the best description. The former were built at the works of MM. Andre Kochlin and Co., of Mulhouse, in Alsace, and the rolling stock was made partly by the wagon-building works at Simmering and partly at a manufactory near Prague.

HEAVY GUN CARRIAGES.

The Russian artillery journal publishes particulars concerning some trials recently made with a self-acting running-out gun carriage, manufactured by MM. Krupp, by command of the Russian Government, and intended for service with the 11 in. Krupp breech-loader for casemates.

The principle of the carriage is such that it utilises the force of the recoil in such a way that the gun runs back up a dwarf platform for a short distance under the action of the brake, and afterwards runs forward again into its former firing position.

The carriage consists of an ordinary carriage, a dwarf platform, the movable brake apparatus, and the appliances for the guns. The wrought-iron carriage rests on the dwarf platform, upon four trucks. The rear tracks are arranged so as to place the carriage automatically upon the platform, and the carriage, in running forward, changes its motion from rolling to sliding, in order that sufficient stability may be obtained when the firing position is reached. The compressor resembles the Armstrong brake, the bars of which are fixed with the dwarf platform upon the carriage, the brake blocks upon the compressor axis, the bearings of which allow a little play at the commencement of the recoil; this arrangement prevents the simultaneous action of the brake, and the resistance of inertia, but this only refers to the first movement of the carriage. The compressor lever is placed on the left-hand side of the carriage between the two catches, by which it is released or fixed, as the gun recoils or runs forward.

The independent action of the compressor, together with the movement of the wheels, effects the running back as recoil takes place. On explosion the compressor remains in inactivity until the carriage, sliding back, throws over the lever by means of the catch, and sets it in operation, at the same time the carriage coming upon the wheels of the rear track, completes its movement with a rolling action.

Gearing applied to the rear end of the dwarf platform effects the lateral training of the gun. For loading, a turning crane was fitted to the carriage for lifting and placing the shot within the gun. Suitable platforms for the gunners are adapted to the dwarf platform. The weight of this latter is 7.4 tons, and that of the carriage is 4.6 tons.

The experiments were made to ascertain the efficiency of the apparatus to execute manœuvres, and especially with reference to the action of the compressor. An 11 in. cast-steel hooped gun, weighing 25 tons, was placed on the carriage. The maximum elevation was 14 degrees, and one gunner performed this operation, three being required for the lateral training. Loading the gun also required three men. The running-out arrangement occupied one gunner on each side of the carriage to place it on the trucks by levers. Formerly eight were detailed to this work by the aid of windlasses.

One hundred rounds were fired, the normal charge being 82.50 lb. of prismatic powder; the weight of the projectiles was 495 lb. The first few shots were fired with reduced charges; the rest with the normal charge. The results of these trials were highly satisfactory, the carriage doing all that was expected from it, after a few alterations had been made, and the ease and increased rapidity in firing were strongly marked.

GLASS GAUGES.

An improved form of gauge has been lately introduced with a view to reduce the fracture of gauge glasses so common. By the new arrangement two tubes are employed, one fitting within the other, so as to leave an annular space around the inner tube, which is of course filled with air. These tubes are mounted in the ordinary manner, and it is found that they are far less liable to break as the inner one is protected from the sudden changes of temperature by the outer tube and the stratum of air contained in the annular space.

WARMING RAILWAY CARRIAGES.

A new method of warming railway carriages is finding favour here. A preparation of wood charcoal, nitrate of potash, and starch is employed. At first the charcoal was burnt in perforated boxes 2 ft. long, 4½ in. wide, and 2¾ in. deep. However, it was soon found that this combustion caused violent headaches, and the charcoal was put into close iron boxes placed under the seats, a double top being employed to prevent the seats of the carriages from becoming too hot. The prepared charcoal is packed in the boxes in pieces 4 in. long, 3 in. wide, and 2 in. thick. On the line between Aix-la-Chapelle and Berlin eight pieces of charcoal were used for heating a compartment. This quantity efficiently warmed the carriage during 16 hours, and at the end of the journey the fuel was still red hot. The prepared charcoal costs 32*s.* shillings a cwt., and the expense of heating one compartment is about three farthings an hour.

A NEW RAILWAY BALLAST.

The residuum from soda manufactories forms an excel-

lent ballast. It is the almost universal practice to manufacture sulphur out of soda waste. After being desulphurised, the remnant consists chiefly of sulphate and carbonate of lime. Employed as ballast this material keeps the sleepers perfectly dry, and preserves the timber. Considerable experiments were conducted with it some time since, and with very marked results. Of course, its application could be only very limited, in consequence of the comparatively small quantity available.

Cast Steel Brake Blocks.

Metal brake blocks, consisting of a combination of cast iron and cast steel, have come into considerable use upon German lines, with results so favourable that they will probably supersede almost entirely brake blocks of wood. They are made of charcoal iron mixed with cast-steel turnings, very carefully selected and tested. It is found that if the blocks are too hard they fracture easily, and if too soft, of course, the wear is excessive. The duration is found to be considerable, and the cost less than that of wooden blocks, whilst the most important feature is the preservation of the tyres and of the permanent way. Experience lasting through two years has shown the wear upon the tyres to be extremely equal, and much less than that caused by wooden blocks, the wheels also become less heated. The reduced effect of iron blocks, as compared with those of wood, is compensated by increasing their weight.

Extraction of Sulphur from Iron Ores.

A new method of treating iron ores for the separation of phosphorus consists in changing the insoluble phosphoric combinations contained in the ore into soluble phosphoric acid, and by separating it by lixiviation. To effect this transformation the ore is treated with a combination of sulphur and oxygen. Pulverised ore containing iron pyrites is roasted as usual, and a porous ore is added which allows the infiltration of the "medicine." The prepared ore is placed in chambers of suitable dimensions, and water is then added containing sulphuric acid, or the acid is applied direct to the ore at the same time that a current of cold water is injected, so that the absorption of the sulphuric acid is effected by the water intermingled with the ore. This last mode is specially adapted to porous ores, as the gas penetrates easily into the pores, and acts more rapidly upon it. The process can be simplified by forcing the sulphuric acid into the ore by means of pumps. The fluid remains in the ore until the effect ceases, and the phosphorus has been changed into solution. It is important to observe this point exactly, and not to continue the combination, otherwise phosphate may be precipitated. The fluid is then drawn off, and replaced by water, which washes out the salt in solution, but not carried away, and the washing is continued so long as any traces of phosphoric acid are visible. The water containing the combination of phosphorus is then heated by fire, or with a coil of steam pipes, in order to separate the sulphuric acid, and to precipitate the phosphates. The acid is either allowed to escape, or it may be used over again if it is mixed with water. The phosphorus, precipitated by the heat, is combined with lime. When the sediments have settled, the clear water is drawn out, and the precipitate is removed, and is used for various industrial purposes. The refined ore is taken out of the vessels and placed in ordinary furnaces to be reduced to pig iron.

SOUTH WALES INSTITUTE OF ENGINEERS.

(*Concluded from page* 270.)

Mr. Thomas Joseph's paper on "Colliery Explosions in the South Wales Coal Field" was then brought up for discussion.

The President considered this subject of such great importance that he hardly thought they should be doing it justice by commencing the discussion that day, as it was getting rather late, and it would, besides, be a convenience to many members to have the discussion adjourned to the next meeting.

The discussion of this paper was accordingly adjourned.

The next paper for discussion was on "Wire Tramways," by Mr. H. W. Pendred, C.E.

The President said this paper was read at the last meeting; he believed it was a subject of some importance in these districts, where the expense would prohibit the making of tramroads or railways. Mr. Pendred had written to say that he much regretted that pressure of business prevented him at the last moment from attending this meeting, and that if the discussion of the paper was adjourned, he should have much pleasure in replying to any questions at the next meeting.

Mr. Thomas Joseph would be glad to know the cost of erection of the wire tramway per mile, so as to compare it with the cost of our colliery tramroads.

Mr. Hort. Huxham said, that in the construction of these lines they were divided into six classes according to the work it was intended for them to do. Class No. 1, comprised those lines constructed to carry 50 tons per day, in loads of ¼ cwt. each. Class No. 2, to carry 100 tons per diem, in loads of 1 cwt. Class No. 3, to carry 200 tons per day, in 2 cwt. loads. Class No. 4, to carry 350 tons per day in 3 cwt. loads. Class No. 5, to carry 500 tons per day in 4 cwt. loads, and class No. 6, to carry 1000 tons per day in 6 cwt. loads. The cost was proportionate to the number of tons to be carried per diem. For a line constructed with framed wood posts, wrought-iron tops and patent pulleys, best steel wire rope, steam power, consisting of self-contained engine and boiler ready for work, pair of terminals wrought iron rolling stock, the price for materials delivered in England would be for class No. 1, 395*l.*; class No. 2, 620*l.*; class No. 3, 990*l.*; class No. 4, 1410*l.*; class No. 5, 2020*l.*; and class No. 6, 2860*l.*; per mile. About 15 per cent. must be added to these amounts for erection on the site of working. A line of four or five miles in length can be constructed at a much cheaper rate per mile, than for a line of only one mile. He had seen a small line in full work, and he found that the load travelled with the greatest facility, passing over the intermediate supporting pulleys most easily, and being received and despatched on the terminal rails at each end with great regularity and ease. He thought the wear and tear was very low for the quantity of material transported by the line, consequent in a great degree upon the loads being so divided and evenly distributed. The model before them was a fair representation of such a line with its terminal rail. He considered that these lines were especially adapted for the transport of light goods over a rough and hilly country, and in localities where either it was impracticable to make a tramway, or too costly to do so. This system was also well adapted for some agricultural purposes, such as the transport of sugar beet, sugar cane, coffee, &c. It had also been successfully adapted to the transport of minerals over country hitherto inaccessible to ordinary tramroads. There are from 90 to 100 miles of wire tramways either constructed or in course of construction, in various parts of the globe. The Spanish Government are erecting some 15 miles. The Indian Government some 10 miles, and there are besides eight lines in England, ten in France, ten in America, two in Italy, two in Sweden, three in Germany, one in Russia, and two in New Zealand. He was of opinion the system was of practical importance, as a transporting medium in those districts where ordinary tramroad communication could not be established.

Mr. M'Murtrie thought there could be no doubt the system of wire tramways could be used with advantage in those districts where it was impracticable or inexpedient to lay down ordinary tramways, but in the transport of coal, by this means, he thought considerable loss would arise from the breakage, consequent on dividing the coal into such small loads, it might, however, be used for carrying away the refuse shale from our pits to our tips.

Mr. Thomas Joseph considered the first cost of the wire tramway to transport 350 tons per day to exceed the outlay necessary for ordinary tramroad communication.

The President remarked that it was not intended to supersede ordinary tramways, but to use the wire tramways in those localities, referred to by Mr. Huxham, where the ordinary modes of communication could not be used.

Mr. Glasbrook remarked that he did not think the rope would last long when carrying large quantities, and he thought it would require renewal every year at very considerable cost.

Mr. Thomas Joseph considered the subject a most interesting one, and the plans exceedingly well got up, and with great care.

Mr. Hussey proposed the adjournment of the discussion to the next meeting, which was seconded by Mr. Thomas Joseph, and carried unanimously.

The Secretary then read a paper giving a brief description of a portion of the Lacawanna coal region, Pennsylvania, U.S.A., communicated by Mr. Richard Evans, formerly of Plymouth, through Mr. William Thomas Lewis.

A vote of thanks to Mr. Evans for his valuable paper, was accorded unanimously. Mr. David Davies proposed a vote of thanks to the President which was carried with acclamation. After the meeting the members dined together at the Mackwarth Arms Hotel.

ENGINEERS IN INDIA.

To the Editor of Engineering.

Sir,—The official pictures of the prospects of civil engineers in the Indian Public Works Department glow with such an uniform *couleur de rose* tint, that great has been and will continue to be the disappointment when the reality is attained and is found to be so dimmed by the sombre greys of a lonely life—of a climate unhealthy to most, uncomfortable to all—of slow promotion, and of the fact that civil engineers belong to the "uncovenanted service," and, therefore, have illiberal furlough and pension rules, and are officially social pariahs!

It is to draw the attention of parents and guardians and young men themselves to this last point, that I write, because it is, what, except with old Indians, is most unlikely to be foreseen and which sooner or later comes to be most keenly felt. It requires some explanation. In old "John Company's" time, his civil servants were divided into two most distinct classes, "covenanted" and "uncovenanted." In the former were all those who came out from England, in the latter, those who were engaged in India, invariably natives and half-castes employed in very subordinate positions. No man having any pretensions to the social position of a gentleman was then supposed to be in the "uncovenanted" service. The two distinct services still exist. Only the revenue and judicial officers, formerly Haileybury men, now "competition wallahs" are considered to be "covenanted." All other civil servants of the Government, Europeans, half-castes, natives, wherever engaged and however employed, all belong to the so-called "uncovenanted" service. In that service, therefore, there are now hundreds of educated English gentlemen holding appointments of great responsibility and importance (notably all civil engineers), but its members are still officially treated as far as rank and position go, as if the service was as it once was composed solely of half-caste and native subordinates, the social status of every one is ignored, left altogether out of the table of precedence of the country. Let it be remembered that this is a matter of very different moment here from what it is in England. Here the vast majority of people one meets in social life are officials, indeed in most up-country stations, a non-official European is not to be found; and let it be remembered, also, that we are surrounded by a people quick to notice our social distinctions, and to be guided thereby in their consideration of and respect for each one of us.

As an illustration of the indignities to which this omission from the precedence table subjects us, here is a case such as is constantly happening. A civil engineer of high standing in the department goes to a "burra Khana"—big dinner—at the judge's or collector's, or wherever it may be, at which all the other guests are "covenanted" or "military," and at which there is one lady less than the number of men. The host or hostess, however reluctantly, has to be guided by rule, and whilst the freshly fledged competition wallah, the juvenile medico, and the ensign march into dinner each with a lady on his arm, our engineer has to follow *solus*, stamped thereby in the eyes of every one as a social inferior. At durbars, levees, and such like public occasions his juniors in the department, nay! his very assistants, if military men, take precedence of the civil engineer, and the brand of social inferiority still stamps and wounds him. Let high spirited young men who think to become Indian engineers mark this.

As a class, we, civil engineers, come from the same stratum of society as the competition wallahs and the officers of the Indian army. Our education, whilst perhaps not quite up to the temporary high-pressure mark of the former, is certainly superior to that of the latter, and in general culture we yield to neither. Then, granting that the "covenanted men" in the higher grades, members of Council, judges, collectors, have positions of importance, such as to entitle them to take rank above us, what reason is there that for all civil engineers, length of service, position, importance of work, are ignored with, as is often the case, thousands of lives and enormous revenue depending on their honesty, vigilance, and professional ability? What reason is there that they should be treated as inferior in rank to all "covenanted" and "military" men, to the salad-green competition wallahs, still "dry nursed" by a native subordinate, and to the juvenile ensign still battling with the goose-step? The injustice of it is so flagrant that we have been daily expecting an alteration; but to our disgust a revised "precedence warrant" for India has just been issued containing the old wrong.

Help, Sir, to make all this known and you will save many a young man from being led blindfold into a position where he is subject to indignity, or—who knows?—you may perchance be the means of having the wrong righted, and so earn the gratitude of the hundreds already misled.

* * * * *

Executive Engineer, Indian P. W. D.

India, October, 1871.

EARLY IN THE CENTURY.

To the Editor of Engineering.

Sir,—I write the following few particulars of times past under the impression that they may prove interesting to some of your readers. In the year 1809 I was put an apprentice at an engineering establishment, where the works consisted of 10 or 12 bench vices, 10 dead centre lathes with cast-iron beds, 1 large lathe, 1 screwing and 1 drilling machine, the whole of which, as well as 2 pairs of cupola bellows, and 1 circular saw, were driven by a 10 horse condensing engine. And as there were no machine tools, surfacing was all done by the chisel and file, and turning with the following hand tools, the hook, the heel, the 3 square, the chisel, the grayer, and the round nose. There were 5 forges blown by common bellows, and 1 heavy forge by walking bellows, and the whole worked by the hand and sledge hammer, the heaviest forging 4½ to 6 in. square by 5 to 7 ft. long, all machine shafting being of cast iron.

Mechanics' wages were about the same then as now, and the price of provisions as high, except that of bread and malt liquors, which are less than one-half now.

Yours respectfully,

Valentine.

American Prices for Bridge Work.—The Philadelphia correspondent of the *Iron Age* gives the following particulars of tenders sent in for the construction of the Fairmount Bridge at the city, a structure of which an illustrated description appeared on page 209 of our eighth volume. He says: "Owing to a difficulty in the former letting of the contract for the construction of this bridge, new proposals were advertised for, and lately opened. As a guide for other work of the same character, the tenders are given as follows: Six works competed, among which are included the leading bridge builders of the country, and the prices named bear a fair proportion to what such work can be obtained at: Kellogg Bridge Company, Buffalo: Wrought iron, 7 cents per lb.; cast iron, 5 cents per lb. Superstructure, two or three trusses, over a street, including lateral braces, 111 dols. per foot. Keystone Bridge Company, Philadelphia: Wrought iron, 8½ cents per lb.; cast iron, 5½ cents; cast iron balustrade, 9.50 dols. per foot; cast-iron railing pedestals, 35 dols. each; ditto column pedestals, 65 dols. each; lamps and stands, 90 dols. each. Superstructure, two trusses, 750 dols.; road trusses, 100 dols. per foot. J. H. Coffrode and Co., Philadelphia: Wrought iron, 8½ cents; cast iron, 5½ cents; balustrade, 9 dols. wrought-iron railing, 6 dols.; pedestals, 35 dols. each; column ditto, 85 dols. Superstructure, two trusses, 900 dols. per foot; road trusses, 100 dols. per foot. John W. Murphy, Philadelphia: Wrought iron, 9 cents; cast iron, 6 cents per lb.; balustrade, 12 dols; wrought railing, 9 dols; pedestals, 75 dols. each; column pedestals, 110 dols. each. Superstructure, trusses, 910 dols. per foot; road trusses, 128 dols. per foot. Phœnix Iron Company, Pa.: Superstructure, trusses, 792 dols. per foot; road trusses, 112-24 dols. per foot. Baltimore Bridge Company: Trusses, 1149 dols. per foot; road ditto, 200 dols. per foot. As will be seen, there is considerable variation in the prices put upon the work. The bridge will be a double deck bridge, with long approaches and a separate elevated roadway over the track of the Pennsylvania Railroad, at the west end. The streets now crossing this track at grade are to be changed so as to cross 24 ft. above the rails. The work is intended to supply the place of the present suspension bridge, now unsafe by age, and will be a large and expensive undertaking."

GERMAN RAILWAYS.

THE CONSTRUCTION AND MAINTENANCE OF PERMANENT WAY.

(*Continued from page 262.*)

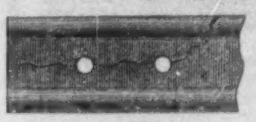
CAST-STEEL RAILS.

OF the many railways which have again reported on this important question, one only—the Baden State Railway—expresses an opinion opposed to the further use of cast-steel rails. In order to justify this decision, the engineers of the Baden State Railway state that during one year 0.45 per cent (18 rails on a line, 15,200 yards long) of the newly laid rails showed a complete fracture which could only be attributed to the brittleness of the material, as the section of fracture at the points where rupture occurred did not show any irregularity in the structure of the metal. Fractures of cast-steel rails have also been reported by other lines, and the following general observations have been made with respect to the cause and seat of these fractures:

1. The fractures of 5 rails out of 2540 laid down in 1866-67 on the Bergisch-Märkisch Railway over steep inclines and on sharp curves were caused through the careless fixing of the rails; the same railway company reports that the only disadvantage found with cast-steel rails up to the present time consists in their brittleness, which necessitates that they should be carefully handled the plate layers.

2. The numerous fractures (16 per cent. in 3½ years) of Bessemer cast-steel rails used on the Brunswick State Railways with a newly introduced iron permanent way structure, are attributed not to the wear and tear of the rails, but to the unfavourable arrangement of the permanent way used. As soon as the latter had been improved, no further fractures of rails took place during the last year.

3. In the case of the Bessemer cast-steel rails used on the Cologne-Minden Railway, it was found that a piece about 15 in. long, frequently broke off



at the end of the rails. The fracture passed in each case through the two holes for the fish-bolts as shown in the annexed sketch. The oval holes

TABLE No. III. SHOWING THE RESULTS OBTAINED WITH CAST-STEEL RAILS.

Reference Number.	Name of railway on which the rails were used.	Name of works from which the rails were supplied.	Quantity supplied.	Weight of rails per yard.	Height of rails.	Length of line over which the rails have been laid down.	Nature of line on which the rails have been laid.			Average number of years during which the rails have been under traffic.	Period of guarantee.	Percentage of the total number of rails which have had to be renewed during the period of guarantee.	Percentage of the total number of rails which have had to be renewed since they were first laid down.	REMARKS.
							Radii of curves.	Gradients.	Average daily number of trains.					
							A. *Crucible Cast-Steel Rails.*							
			tons.	lbs.	in.	miles.	ft.			years.	years.	Two rails of 21 ft.		
		Krupp, of Essen	1282.8	85.5	5.12	9.866	2470 and 12,250	1 in 200—1 in 1200	12 to 30	2	10	0.0079	0.0079	Six rails broke when taken from the wagon; two rails broke vertically about 3 ft. 3 in. from the end.
1	Lower Silesian Railway	Eberhard, Hösch and Sons	36.4	85.5	5.12	0.294	4329	1 in 300	12 to 30	2	10	...	...	Have stood well.
		Hörder Hütte	21.2	85.5	5.12	0.171	...	1 in 300	12	3	10	...	...	"
		Bochum Association	36.5	85.5	5.12	0.326	6170	1 in 1224	13	1½	10	...	...	One rail broke in cold weather; with that exception the rails stood well.
2	Eastern Railway of Prussia	Eberhard, Hösch and Sons, of Düren	24.7	82.9	5.12	0.099	3706	1 in 200	12 trains with much additional shunting	3	5	...	...	Without faults.
		F. Krupp, of Essen	23.7	85.2	5.12	0 122	4940	1 in 200		2½	...	...	...	A peeling off of the top of the rail has lately been observed.
3	Western State Railway of Saxony	Hörder Hütte	17.1	69.41	4.6	0.170	none	1 in 110 and 1 in 200	28	3	10	...	...	
			68.35	69.41	4.6	0.675	1850 and 2788	1 in 100	20—25	3	10	0.126	0.124	Supplied and laid down in 1868.
4	Eastern Railway of Saxony	Hörder Hütte	83.	71.5	4.6	1.022	...	1 in 55	16	1.62	10	...	...	A small portion of these steel rails are laid down at the station on a shunting line, where the iron rails had to be renewed twice yearly.
		Brown, of Sheffield	13.45	71.5	4.6		...	1 in 55	16	1.62	un-known	...	...	
		Not known	5.5	71.5	4.6									
5	Wurtemburg State Railway	F. Krupp, of Essen	101.2	81.36	4.5	0.743	980	On the entire length, 1 in 45	At least 13 trains and as many pilot engines	1½	8			
6	Southern Railway of Austria	Mayer, of Lesben	0.96	85.93	3.	0.011	...	1 in 40	20	6				
		Total	1717.8	...	...	13.569								
							B. *Atlas Cast Steel.*							
1	Western State Railway of Saxony	Brown, of Sheffield	0.94	73.38	4.6	0.0082	1860 and 3716	1 in 100 and 1 in 40	430, 30, and 16	4½				
		Total	0.94	...	...	0.0082								
							C. *Bessemer Cast-Steel Rails.*							
1	Altona-Kiel Railway	Dowlais Iron Works	2.63	72.32	4.5	0.025	1302	1 in 140	15	4	5	...	...	
			1.47	...	...	0.014	...	...	...	1	...	...	...	
2	Berlin-Hamburg Railway	Guest and Co. (England) through Robertson, Hamburg	178.7	80.1	4.72	about 1.86	...	...	Station at Hamburg	1	5	...	...	The rails stood well.
3	Brunswick State Railway	Hörder Hütte	63.2	48.	2.91	0.910	7410	1 in 1040	32	3½	trial	...	16.0	The rails in question are top rails of an iron permanent way. The central webs of these rails had been provided with holes in order to fasten them to the bottom rails, and these holes were the cause of the fractures, for when another arrangement of fastening without holes through the web had been adopted, the rails ceased to break.
4	Lower Silesian Railway	Krupp, of Essen	349 8	84.5	5 12	2.732	4965	1 in 250 to 1 in 1027	25	1½	10	...	...	One rail broke before being laid down.
5	Eastern Railway of Prussia	Königshütte	about 58.2	...	...	0.471	...	1 in 200	...	1	...	...	0.0	220 of these rails had been ordered with a harder top than the remaining 230.
			about 55.7	...	...	0.459	...	1 in 200	...	1	...	...	6.8	Fifteen of the former rails had to be renewed in the winter of 1868-69 on account of longitudinal cracks, which began at the holes for the fish-bolts and extended, partly horizontally and partly vertically.
6	Wurtemburg State Railway	Bochum Association	101.2	82.3	4.5	0.75	980.5	1 in 45	13, and as many pilot engines	1½	8	...	...	
7	Kaiser Ferdinands Nordbahn (Austria)	Prevali	219.54	70.	5.35	2.201	straight	1 in 500	44	2½	8	0.00	0.00	
		"	200.00	"	"	2.016	"	1 in 2000	39	2	8	0.91	0.91	
		Burbscheidon	309.17	"	"	2 908	"	Horizontal	39	2	3	0.62	0.62	
		Prevali	61.1	"	"	0.613	"	1 in 500	44	2	8	1.39	1.39	
		Witkonitz	280.00	"	"	2.806	"	1 in 500	39	2	5	0.38	0.38	
		"	298.20	"	"	2.998	3706	1 in 200	35	2	5	0.93	0.93	
		"	860.25	"	"	8.625	straight, 6220, 4976.4, 3321, 3421	1 in 300, 1 in 500, 1 in 600, 1 in 800, 1 in 400	13	1	6	0.00	0.00	
		"	660.80	"	"	6.624	straight, 2486.2, 6220, 9321, 3421	1 in 400, 1 in 300	16	1½	6	0.03	0.03	
8	Southern Railway of Austria	Iron Works of the Southern Railway at Gratz	50.6	81.36	5.	0.434	930 and 1235	1 in 90	13	1	3			
		Total	3750.36			36.345								

TABLE No. III.—*Continued.*

Reference Number.	Name of railway on which the rails were used.	Name of works from which the rails were supplied.	Quantity supplied.	Weight of rails per yard.	Height of rails.	Length of line over which the rails have been laid down.	Nature of line on which the rails have been laid.			Average number of years during which the rails have been under traffic.	Period of guarantee.	Percentage of the total number of rails which have had to be renewed during the period of guarantee.	Percentage of the total number of rails which have had to be renewed since they were first laid down.	REMARKS.
							Radii of curves.	Gradients.	Average daily number of trains.					
	D. *Cast-Steel Rails* (*the particular kind of Steel not being stated.*)		tons.	lb.	in.	miles.	ft.			years.	years.			
1	State Railway of Baden.	Not given	about 1063	...	...	8.63	1170 to 2960	1 in 60	...	1	...	...	about 0.45	The rails to be renewed had been laid down on curves, and all showed complete transverse fractures; defects in the permanent way could not be observed at these places, whence the fracture could have been caused only by the brittleness of the material.
2	Bergisch-Märkisch Railway	Not given	about 364.7	...	...	about 3.1	1030	1 in 70	...	3	...	...	about 0.1	Only five miles had to be renewed on account of fractures caused by a careless bedding of the permanent way; the wear and tear of the rails is uniform but insignificant, and the only disadvantage consists in the brittleness of the material, necessitating a most careful handling of the rails.
3	Cologne-Minden Railway	Krupp, of Essen Hörder Hütte	about 2115	82.73	5.25	about 76.26	...	...	...	1	...	...	...	Several rails were broken during the transportation, though they had not been notched; besides, several fractures occurred on rails under traffic, when a piece of 1 ft. or 1½ ft. long, broke off at the end of the rail; the fracture always passed through the holes for the fish-bolts.
4	Upper Silesian Railway	Krupp, of Essen Bochum Association Hörder Hütte Königshütte Bury	4951.6	83.14	5.2	40.22	1175 to 2350 and upwards	1 in 60 to 1 in 150	34 to 44	1½	5—12	0.2	0.2	Up to the end of 1868 the fractures on eight cast steel rails occurred at the notches; the fractures of four rails (0.014 per cent.) took place under traffic, whilst four other rails broke during transportation. The filing off of the clinching places has given satisfactory results.
5	Breslau-Posen Glogau Railway	Bochum Association Hörder Hütte Krupp, of Essen	2247.9	83.14	5.2	18.26	3706 and upwards	1 in 100	16 to 24	1½	5—12	0.2	0.2	
6	Rhenish Railway	Not given	about 46.5	...	...	about 0.37	...	...	...	1	...	...	0.0	
	Wilhelms Railway	Not given	5.05	...	5.2	0.044	Not given	...	Lines of rails very frequently used	5	...	...	...	Rails 18 ft. 6 in. long.
			3.08	...	...	0.023		...		4	...	...	...	Rails 21.6 ft. long.
			46.40	...	...	0.390		...		2	...	...	...	" "
			136.50	...	...	1.116		...		0½	...	...	...	" "
		Total	17978.68	...	...	148.463								

for these bolts were formerly punched, but they are now made by first drilling a round hole and afterwards enlarging it by a slotting machine; it has not yet been ascertained, however, whether this will prevent the fracture just referred to.

4. Of the cast-steel rails laid down on the Upper Silesian Railway over a line of 103,140 yards, four rails have broken during about one year and a half at the points where they were notched for the spikes, and several more broke at the same points in consequence of careless handling. Experiments made on that railway, however, tend to prove that the notching of rails ceases to be injurious, if the punched notches are filed over so as to remove the minute cracks left around the notches by the punch. We should like to have some further evidence on this point.

5. Bessemer cast-steel rails have broken through at the notches on the Saxon State Railways and on the Westphalian Railway.

Contrary to the above observations the administration of the Kaiser-Ferdinand Northern Railway of Austria reports that not a single fracture occurred in the Bessemer cast-steel rails which were laid down on that railway in 1868 and 1869, whence it appears that in this case the rails have been made of a homogeneous material free from brittleness, the fault of making them too hard with a view of obtaining increased wear having been avoided. It should be mentioned, however, that the rails on the Kaiser-Ferdinand Northern Railway are not notched. According to the experience gained on the Westphalian Railway, the durability of the Bessemer cast-steel rails exceeds that of all other rails, to an extent which renders them relatively cheaper than any others.

The administration of the Kaiser-Ferdinand Northern Railway reports further, that, contrary to their expectations, some of the Bessemer steel rails have been flattened at the top. The cause of this damage is attributed to the existence of flaws or blisters in the ingots which cannot be removed even under the heaviest steam hammer, and thus if the rails are rolled out of these blooms, the thin portions that cover these flaws at the surface of the rail are gradually worn off. The general wear and tear of the Bessemer steel rails is reported, however, to be uniform but insignificant; and the administrations of several other railways repeat this statement.

Observations made on the Bergisch-Märkisch Railway have shown that cast-steel rails used for sharp curves tend, on account of their great elasticity, to return into a straight line; this circumstance makes it difficult to keep the proper gauge, and a frequent rebending of the rails becomes necessary. Finally, there is recorded an order of the Belgian Government which is of some interest; this order being to the effect that cast-steel rails must be adopted on all new Belgian railways on gradients of 1 in 75 and steeper inclines. Table No. III. on the present and preceding pages, contains a record of numerous results obtained with steel rails on German railways.

(To be continued.)

LITERATURE.

A Digest of Facts relating to the Treatment and Utilisation of Sewage. By W. H. CORFIELD. London and New York: MacMillan and Co. 1871.

[FIRST NOTICE.]

THAT a second edition of this work has appeared so soon after the first was issued to the public is perhaps due to the fact that the first edition was prepared for the British Association Committee appointed at the Exeter meeting of 1869 to report on the treatment and utilisation of sewage. Mr. Corfield accordingly prepared this digest of the facts, but it was considered by some members of the committee at Liverpool that if the book were issued to the public under their auspices they might be considered answerable for the author's conclusions on the subject, and bound to opinions which they did not hold. Accordingly, with extensive alterations and improvements, the second edition appears, and forms, apart from the too bulky official reports of various commissions, the most complete and valuable treatise on sewage, its evils and its value, that has yet appeared.

It will not be possible within the limits of one notice to consider Mr. Corfield's book so completely as we intend to consider it, and therefore it will be most convenient to divide the subject into the heads that naturally suggest themselves — the sanitary condition of towns and the means that have been taken to improve their condition and to convert into a source of profit the impurities which, if left to themselves, become the most lively causes of degradation, disease, and death. It will scarcely be realised that even to-day many of our large towns are without the most necessary and primitive means for removing the sewage collections from their midst, and that they suffer them to accumulate, with what result let the death-rate show. Thus, for example, as we stated lately, Birmingham, although that town poisons the only running water within her reach, has 13½ acres of cesspool, much of which lies immediately below the floors of manufactories and buildings, which are at all times impregnated with the horrible emanations which arise from them.

In a short space Mr. Corfield has placed before us many particulars extracted from various reports upon the subject. Thus we find that in 1861 many towns were unprovided, even in their centre, with any pretence even at cesspools, and that, as a consequence, the foulest sewage matters encumbered the surface, and also in 1864, as for example in Penzance, where débris of all kinds were cast from the upper windows into the streets, while to go back a little further (1854) there were very many towns where neither privies nor cesspools were provided, and the street itself was employed for all purposes. In 1844 Dr. Duncan reported of Liverpool that 20,000 persons lived entirely without any accommodation. It is difficult to realise that these things existed so recently, and indeed that there exists in many places, to the present, such an utter disregard of the first requirements of health.

Passing from the crowded centres, where no

kind of accommodation existed, we come to the most primitive of arrangements, the "midden heap," on which refuse of all kinds is allowed to accumulate, and is gradually removed as it is required for manure. Following this is the excavation in the ground unconnected with any drainage system—the cesspool—with more or less accommodation, according to the condition of the districts in which they were made. In 1844, a health report on the town of Liverpool stated that in many of the large courts in that town, "there were usually the privies with an ashpit between them situated within 3 or 4 ft. of the doors and windows of the houses at the upper end, and which are the common property of all the houses in the court. These offices are often in such an abominably filthy and ruinous condition, as to make it a matter of wonder how they can possibly be used; the ashpits are entirely uncovered, and the door of the privy is sometimes absent, having been broken or become dilapidated from age. In many instances the inhabitants of the front houses and cellars make use of the convenience in the court, so that the ashpits generally become full to overflowing long before the nightmen make their appearance to empty them." Such is a picture of the condition of things that ruled in 1844, and to a much later date in Manchester, Liverpool, and other large towns. More recent reports dwell in detail upon the condition of the regular cesspool, a brick-lined, covered-in reservoir for the reception of filth, and which concealed at least the glaring abominations of which we have spoken. But where no proper means were taken for the periodical cleansing of these receptacles, not only did their contents percolate through the lining into the soil, but they frequently overflowed, causing the greatest danger and inconvenience. Occasionally, when the nature of the soil favoured such a result, as at Guildford and Northampton, the moist excreta were entirely absorbed, the contents of the cesspits remaining dry and inoffensive, so that they never required cleansing, and produced no offence to the senses. But they produced a worse effect, for the sewage matter percolating through the soil mingled with the springs, and entered largely into the water in the wells from which houses were supplied. In many cases the contamination was apparent to the sight and taste; indeed, communication was so well established that there was almost a direct flow from the cesspool to the well, as indicated by the presence of chloriated water in the latter whenever chloride of lime was thrown into the former. In other cases the water from the well appeared uncontaminated, being clear and sparkling, yet containing deadly matters in solution. Innumerable instances might be adduced of this combination of sewage and drinking water, and of the consequences of the same, and in the first report of the Rivers' Pollution Commissioners, published in 1868, we find some interesting analyses of well-water contaminated from cesspools. Thus, at Liverpool, samples were taken showing 86.7 parts of solid impurity per 100,000, containing 35.51 of carbonate of lime, 12.61 parts of chlorine, and 8.721 parts of combined nitrogen, of which 8.678 parts were derived from sewage contamination, an amount which may be judged of from the statement that, after its descent to earth as rain, 100,000 lb. of the water had been contaminated with refuse animal matter, equivalent to that contained in 86,510 lb. of average London sewage.

Of the direct physical and indirect moral effects of a state of things, such as that we have hinted at, but little need be said. It is true that nature is so accommodating, even under the most unfavourable conditions, that it is only under abnormal circumstances, such as a season of epidemics, that the mortality of adults is very strikingly marked, the percentage of deaths being swelled considerably by the number of young children who fail under the process of acclimatisation. But whether in crowded districts, where, in the unwholesome courts, in crowded houses, or in noisome cellars, the inhabitants eat, drink, and breathe sewage, or in the open country, in villages, such as Terling for example, whose wells and cesspools freely interchanged their contents, the population who sustain life well enough under ordinary conditions, perish wholesale when epidemic roots itself in its most congenial soil. In many places, indeed, epidemic is still chronic, recurring annually with more or less violence, under different forms, at various seasons of the year; and though we must turn back the page of history for several centuries before we arrive at the maximum result of mortality, a maximum amount of filth could generate, we have in our own time, nay, even to the present day, the localities of epidemics so clearly defined, that if laid down upon a map, they would point out those spots where draining was most defective, and water supply most impure, and it follows, as a matter of course, that cholera, fever, and all diseases nurtured in filth, quit a district when their quickening cause is removed.

It is a curious fact that, until comparatively recently, the population of the island of St. Kilda, where pure air and water are abundant, suffered a constant diminution, and that it was recruited from time to time from the mainland to prevent the place from becoming depopulated. Epidemics are partly answerable for this, but infant mortality is the grand cause. Eight out of every ten children born, die between the eighth and twelfth days of their existence, an astounding result due to the horrible state of filth with which the houses are surrounded.

When municipal attention was forcibly drawn in various towns to the imperative necessity of improving the sanitary conditions then existing, the problem arose which has never been satisfactorily settled, as to the best means for making an efficient reform consistent with a reasonable outlay, and calculated to meet with the concurrence of the population, for it must be remembered that individual help is necessary to the carrying out of all sanitary schemes, and experience has shown that a population accustomed to no system, passively or actively oppose reform, even though it carry with it increased comfort and health. Ash-pit middens are largely in use in provincial towns; thus at Nottingham, the old midden pits were lined with cement to make them impervious, the bottoms were made concave, and doors are provided for throwing in dry ashes. These pits hold 80 cubic feet up to the level of the ash-pit door sill, and one lengthened pit is sometimes made under a row of closets when they are built on the block system. The pits are emptied quarterly, and when properly managed they create no nuisance. The cost of these closets and pits is from 9*l.* to 10*l.* for single ones, and from 5*l.* 10s. to 6*l.* 10s. when built in a block. At Stamford a similar system prevails, but the pits are shallower, and the ashes are thrown in from the closet and not from a door; the cost of construction appears a little higher than at Nottingham. In Manchester again, the midden pit system largely prevails. The arrangement carried out is to deodorise as far as possible by means of ashes, with an improved form of ash-pit, of which a grid permitting only the passage of the finer ashes, which are thrown on the fæcal matter, whilst the larger portions are retained, to be again used as fuel. This plan is often combined with a special urine catch pan, which separates the liquid excreta, and keeps the pit dry. Ventilating flues pass upward outside the walls above the eaves of the houses, and a door easily accessible behind the pit allows of their being emptied when desired. With certain variations the midden pit system is in use at Salford, Hull, and several other towns, but in Hull no pits at all are used, the space beneath the seat being used as a receptacle, an arrangement suitable enough within restricted limits, but full of objections and inconveniences when they are not properly used, or when they have to accommodate many people; in the latter case the cleansing becomes a matter of constant work, involving much inconvenience and expense. Indeed scavengering expenses are unavoidable in systems of this and kindred classes. By the system followed in some other towns, impervious cesspools receive the house drainage, forming reservoirs of more or less capacity for the reception of all domestic refuse, the liquid portions draining off into a sewer. In Liverpool, so long ago as 1846, cesspools, &c., drained into the sewers, a measure which, of course, rendered the very existence of these intermediate receivers unnecessary. It is on the Continent that the cesspool system is carried out in its full force. They are of course made impervious, placed in some accessible situation, and are frequently provided with a ventilating shaft. They are large enough to require emptying only about once in four months, and this is done either by pumping direct, or by employing air-tight and exhausted carts, with which and the cesspool a connexion is made, and the contents are forced by pneumatic pressure into the carts. In Paris the cesspools are often provided with a separator, to keep the solids and liquids apart. This is done by having two or more reservoirs, through which the liquid parts pass, each of these chambers being furnished with a ventilating shaft. By this arrangement it is found that decomposition is greatly retarded, and ill odours are prevented. Mr. Corfield criticises the general arrangement of Continental towns with the strictest justice; and the remarks are in place in his book, in a review, however, it is not necessary to reproduce them.

The "Fosses-Mobiles," which are much in vogue in Brussels, consist simply of a stoneware soil pan, without woodwork, the connecting pipes from the bottom of which join the descent pipes without any syphon, and at a very acute angle. The excremental matters, coming through the descent pipe, fall into a tub placed beneath, and holding from 44 to 66 gallons. The cover of this tub is air-tight, and the whole concern is mounted on a little truck, so that it is easy of removal. The inside of the tub is tarred, and the truck runs upon rails laid down on purpose. To the upper end of the descent pipe is fixed a ventilation pipe, rising to the top of the house, and carrying off any ill odours. The expenses connected with this contrivance are said to be small, and the price of the manure more than compensate for the outlay.

The cost of a "fosses-mobile" with separator is about 2*l.* 10s., and for one having three divisions, and so serving several descent pipes, 6*l.* 10s. or 7*l.* "The expense of emptying the solid matter alone for a house of 30 persons, and furnished with a 'séparateur mobile,' is—removal of 12 boxes at 1 franc 50 cents a year, 18 francs; hire of apparatus, 20 francs; that is, 38 francs, or about 1*l.* 10s. a year altogether." At Berlin, Leipsic, &c., arrangements essentially similar to the above are in vogue, and in several English towns a similar, although apparently less perfect, system has been carried out. Advantageous as it is in some respects, there are many reasons why in large towns it is unsuitable for adoption, not only from the large number of receptacles required, but from the inconveniences and danger that would be created, especially in seasons of epidemic. Mr. Corfield quotes a calculation of Dr. French, medical officer of health for Liverpool, in which he estimates that the number of vessels required for the borough would, when closely packed, cover an area of 11 acres 2 rods and 32½ perches, and would extend, if ranged in a line four abreast, for a distance of 12 miles.

IRON MANUFACTURE IN FRANCE.

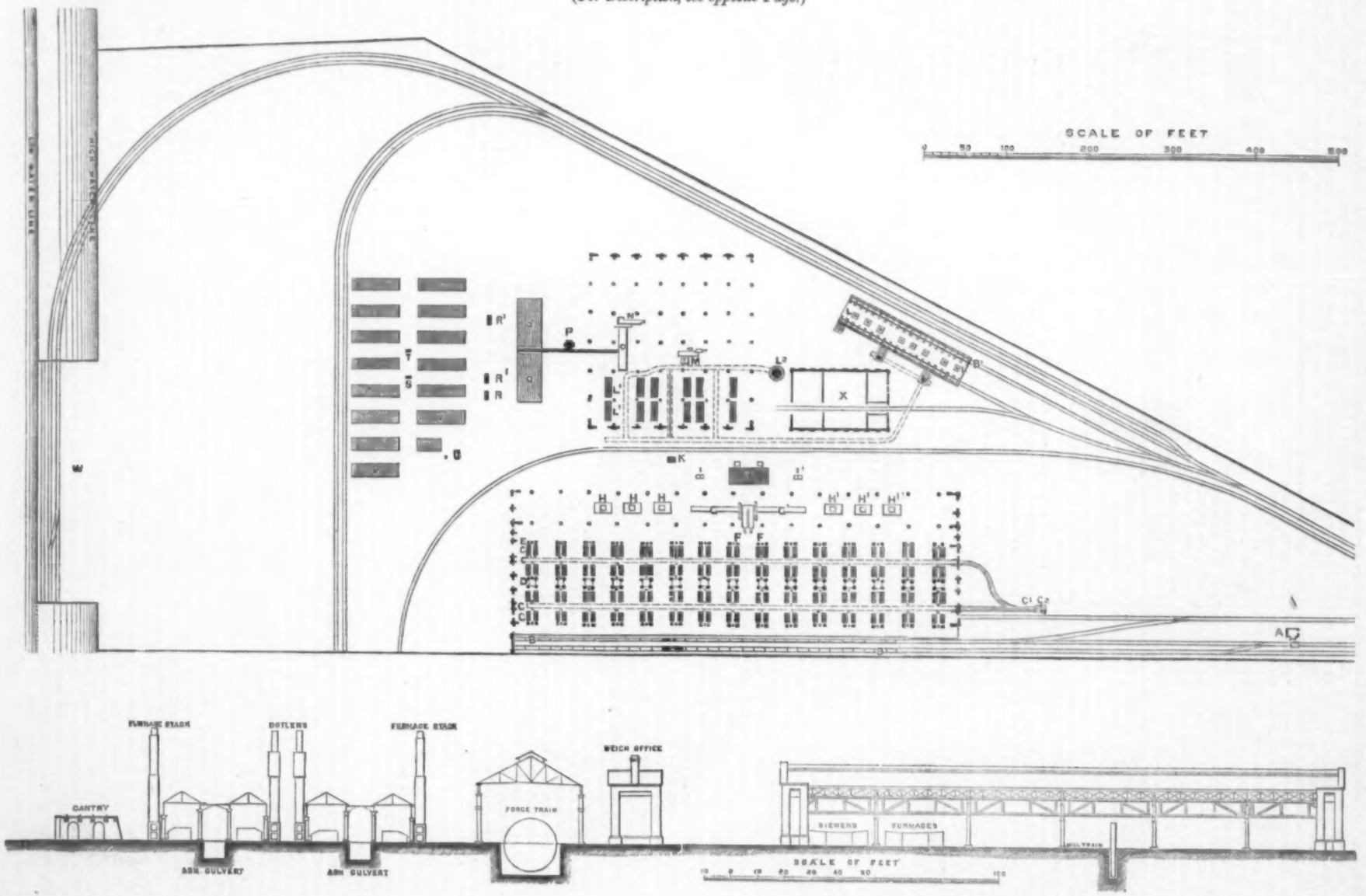
Serious attention is now directed in France to the establishment of new works in that part of the Department of the Meurthe which remains to the country, as well as to the great extension of various existing works. We have already noticed the exceptionally favourable opportunities which the peculiar conditions of France now offer to the various iron industries. Although so large a proportion of the mineral districts has been ceded to Germany, there remains, as we have shown, abundance of ore, easily extracted and worked, with coal and coke at low prices from the Department du Nord, and the Prussian basins, together with an ample supply of labour on favourable conditions, and every facility of transport by railway and canal. It is true that easy terms of import have been accorded to the annexed departments for the benefit of their industries, but these arrangements are exceptional and temporary; the annexation will of necessity have the effect of taking away 150,000 tons of iron annually from France, whilst the demand in the country increases each year by about 50,000 tons.

It is, moreover, evident that there will be with reviving industry, a large field for the sale of cast and wrought iron, and that there will be room for highly remunerative enterprise in the mineral districts. That the project we have spoken of will find ample favour, there is every reason to believe, and we have no doubt that English capital will flow into these channels of assuredly profitable investment.

An Old Steam Engine.—The Spanish cinnabar mine of Almaden, is one of the last places where one would expect to find one of Boulton and Watt's original engines, but it appears that one was erected there in 1799, and has been at work ever since.

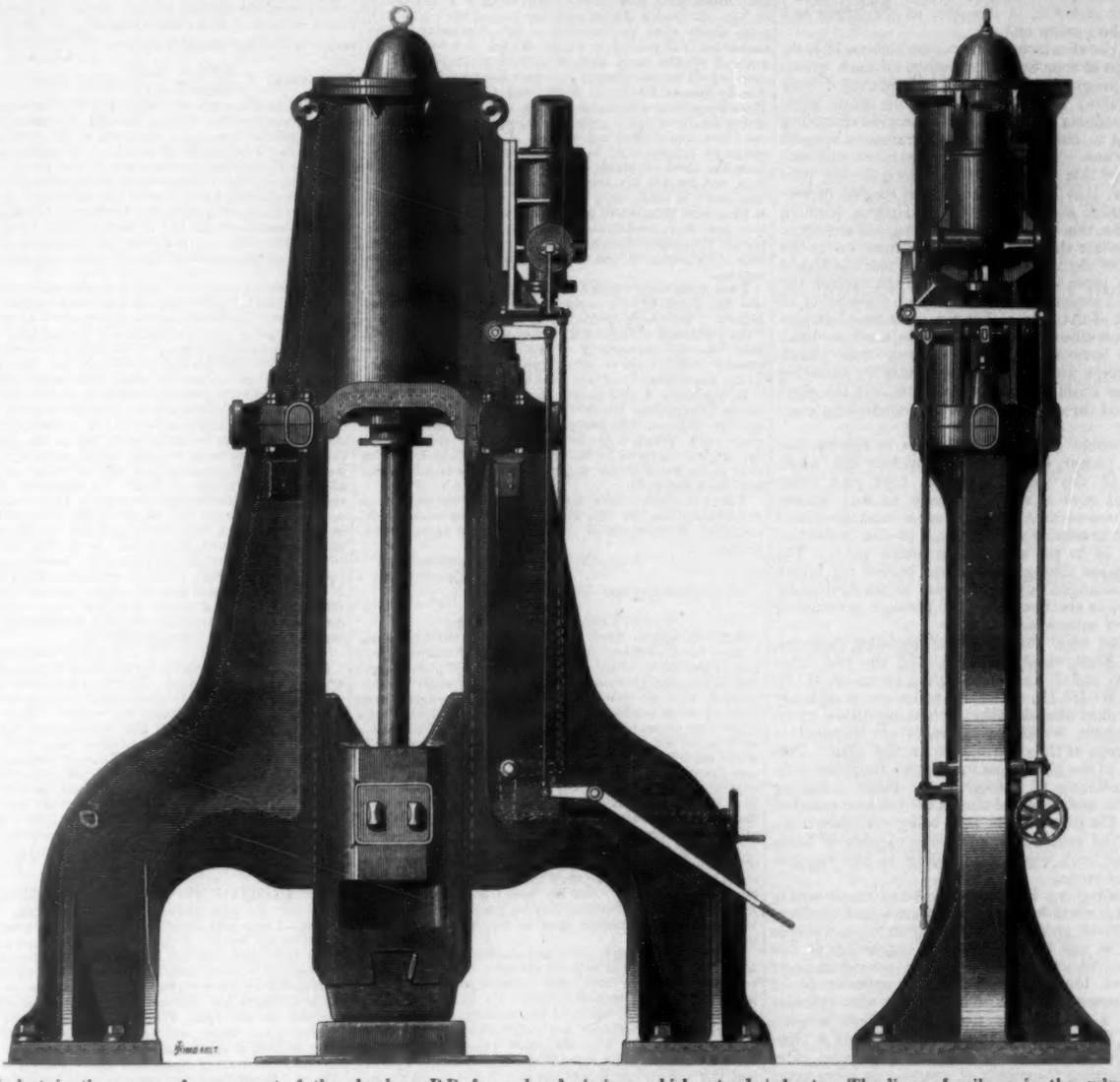
GENERAL PLAN AND SECTION OF THE BRITANNIA IRONWORKS, MIDDLESBROUGH.

(*For Description, see opposite Page.*)



SIX-TON SHINGLING HAMMER AT THE BRITANNIA IRON WORKS, MIDDLESBROUGH.

CONSTRUCTED BY MESSRS. THWAITES AND CARBUTT, ENGINEERS, BRADFORD.



In July last, in the course of our report of the meeting of the Institution of Mechanical Engineers at Middlesbrough, we gave a brief account of the Britannia Works, belonging to Messrs. B. Samuelson and Co., and we at the same time stated that we hoped to be able to describe them in greater detail. This we now propose to do, accompanying our description by a complete set of engravings of the thoroughly modern plant with which the establishment is provided. The Britannia Works are intended solely for the production of rails, fish-plates, and their accessories, and they have been laid out with great judgment, and attention to that direct sequence of all the manufacturing processes which is a distinguishing feature in all modern first-class works.

The general arrangement of the Britannia Works will be best understood by reference to the plan and enlarged transverse section, which we publish on the opposite page. The works are situated close to the River Tees, that river flowing parallel to the western side of the works as shown on the left of the plan. A wharf, W, on the river bank, connected with the works by lines of railway, gives every facility for employing water carriage for the transport of raw materials or finished products, while from the other or eastern end of the works branch lines lead off to the North-Eastern Railway. Of the branch lines just mentioned one set, after passing a weigh-bridge, marked A in our plan, is led direct to gantries extending over a range of bunkers, B B, for coal and pig iron, which extends along the southern side of the works for a length of about 500 ft. Referring to the section, it will be seen that the lines pass over the tops of these bunkers, and the wagons can thus discharge their contents direct into them. The bunkers, B, contain the coal and raw pig for supplying the puddling furnaces; the coal required for the gas-producers belonging to the Siemens furnaces employed for heating the rail piles, being brought into the works by another branch, and discharged into two other ranges of bunkers, B′B′, situated on the northern side of the works, close to the gas-producers, L.

Parallel to the range of coal bunkers, B B, are four rows of puddling furnaces, C, C, C, C, there being 30 furnaces in each row, or 120 in all. These fine ranges of puddling furnaces—the finest, probably, in existence—are roofed over by four lines of light iron roofing, as shown in the section, the spaces between the roofs giving ample ventilation. The length of these ranges of roofing, as well as of that over the forge train, is 540 ft. Between the first and second, and third and fourth rows of puddling furnaces subways or culverts, roofed with cast-iron plates, are carried along beneath the floor level, as shown in the section. These culverts are traversed by narrow-gauge railways, on which run trucks or "bogies" for receiving the ashes and cinders, which are discharged into them from the puddling furnaces through conveniently arranged shoots. The lines of railway in the culvert converge to the point, C², where there is an hydraulic lift, by which the narrow-gauge trucks can be raised, and their contents discharged into ordinary railway wagons, standing on an adjacent siding communicating with the North-Eastern system. This arrangement of subways is exceedingly convenient, and by means of it the ashes and cinders are got rid of with a very small amount of manual labour, and without any trouble arising from the moving about of cinder wagons amongst the puddling furnaces. Referring to the plan, it will be seen that the puddling furnaces are disposed in pairs, these pairs being about 35 ft. apart from centre to centre, longitudinally (thus giving a clear space of about 22 ft. between the successive pairs), while passages, 12 ft. wide, are left over the culverts between the rows of furnaces, so that there is ample space for the men.

Of the four rows of puddling furnaces the two outer rows work direct into ordinary stacks, E, while the two central rows are provided with upright boilers, as shown in the section. These boilers are increased in diameter at their upper ends, so as to give a greater area of water surface, and to enable them to be more readily entered for examination, and each is traversed by a single vertical flue, intersected by seven Galloway tubes. The boilers are each 4 ft. 6 in. in diameter for the main part of their length and 5 ft. in diameter at the enlarged upper portion, while their total height

is 28 ft., the height of the enlarged part being 9 ft. 3 in. The internal flue is 2 ft. 6 in. in diameter at the bottom and has a conical top tapering to 1 ft. 9 in. in diameter. The seven Galloway tubes by which, as we have mentioned, each flue is intersected are each 8 in. in diameter at the larger and 4 in. at the smaller end.

As will be seen from the plan, the boilers, D, form 15 groups of four each, the boilers of each group being connected by branches (each provided with a stop valve) to a single descending steam pipe, which conducts the steam to a main pipe extending from end to end of the range of furnaces beneath the floor line. To enable the expansion and contraction of this main pipe to be conveniently provided for, it is laid in three equal lengths or sections, which are connected by U-pipes, forming long forks, the sides of which spring sufficiently to accommodate the expansion and contraction of the sections of the main line of pipe. From the forked junction pipes steam is led off to the various engines and steam hammers, the steam pipes being all kept out of the way, and at the same time left perfectly accessible, by being laid in shallow brick culverts covered by loose cast-iron floor plates. Steam traps are provided at intervals for removing the water arising from condensation, and the pipes are coated throughout with a non-conducting composition.

The whole range of 60 boilers is fed by two donkey pumps, a feed pipe extending the whole length of the range, and this feed pipe being furnished with a vertical branch to each group. From these vertical branches other branches fitted with the necessary valves extend to the individual boilers, as in the case of the steam pipes. The sludge pipes through which the boilers are blown off are arranged in the same way as the feed pipes. The boilers are worked at an average pressure of 50 lb. per square inch.

Parallel with the ranges of puddling furnaces, and in front of them, are placed the two forge trains, G and G, and six shingling hammers, H, H, H, and H′, H′, H′. The two trains are completely independent of each other, each being driven by its own engine, while the hammers are disposed in two groups of three, as shown in the plan. This portion of the plant thus forms two duplicate sets, each consisting of a forge train, three shingling hammers, and a pair of shears for hot iron (marked I, I′ in the plan), these sets being perfectly independent of each other, and being capable of being either or both worked, according to the requirements of trade.

The shingling hammers are 6-ton single-acting hammers, made by Messrs. Thwaites and Carbutt, of Bradford, and they are of very strong and simple design, as will be seen from the engravings of one of them, which we publish on the preceding page. Each of these hammers has a cylinder 30 in. in diameter, and 4 ft. 6 in. stroke, this cylinder having a steel piston fitted with Ramsbottom's rings. To the side of the cylinder is fixed a compound valve-box, containing the regulator valve for governing the supply of steam—this valve being worked by means of a screw and hand wheel, as shown—and also piston valves, worked by a lever handle, and which are arranged so as to allow the steam to be exhausted from the lower to the upper end of the cylinder. The cylinder is well braced throughout its length by four strong ribs, which spring from its base, this base being made to span the tops of the two standards, and being secured to them by hoops shrunk on, as shown in the front and side elevations, in addition to being well bolted. The standards, which are very strong, are of a box section, and are of such a shape as to enable the tup to be thoroughly guided throughout its stroke, and well supported when the strain is thrown upon it by the blow.

(To be continued.)

THE "ALLEN GOVERNOR."

To the Editor of Engineering.

Sir,—Referring to your notice of the "Allen Governor" in the last number of Engineering, we beg to say that we are the sole licensees in Europe for the manufacture and sale of this excellent governor, and hope in a few weeks to be in a position to execute all orders promptly.

We have two of "Allen's Governors" at work in this town, both of which are giving the greatest satisfaction after several months' trial.

We are, Sir, yours truly,
Whitley Partners.

Railway Works, Hunslet-road, Leeds, Nov. 6, 1871.

STEAM ENGINE COEFFICIENTS.

To the Editor of Engineering.

Sir,—As Mr. McFarlane Gray has again referred to the question whether the steam engine coefficients were known to, and used by Messrs. Randolph, Elder, and Co. before the year 1864, when he first mentioned it to Mr. Alexander Elder, and has endeavoured to throw some doubt upon the veracity of Mr. Alexander Elder's statement, will you allow me to inform you that I was engaged in the early part of 1861, here in London, in checking all the calculations in a work intended for publication, by Messrs. Randolph, Elder, and Co., describing and illustrating their compound engines and boilers, and also giving details of their performance, accompanied by indicator diagrams worked out in full. I arranged these diagrams in proper order to be lithographed, and amongst them the sheet of which Mr. Alexander Elder sent you a copy, and the late Mr. John Elder himself explained at that time (early in 1861) these coefficients and their use to me, as they were then quite new to me, and remarked: "We have used these coefficients for several years, and they have been of the greatest benefit to us in comparing the performance of the steam in our engines with other non-expansive engines."

From some notes which I have still by me, I find that the late Mr. John Elder's explanation of the coefficient is as follows: "The steam of this engine"—referring to Bogota—"has performed a diagram 2.54 times larger than it would have done non-expansively with a perfect vacuum at the pressure of 4.6 lb. above zero, or perfect vacuum diminished by the loss of heat due to the work performed."

In conclusion, I wish to state that the three different dates on the lithographed sheets are the dates on which the respective diagrams were taken, as plainly stated on the lithograph, and, further, that the coefficients were worked out on the original diagrams by the late Mr. John Elder himself as soon as he received the diagrams, and were merely copied into the lithographs.

I hope that these facts may at once set the question at rest whether the late Mr. John Elder was or was not the originator of this mode of calculating steam engine coefficients.

I am, Sir, your obedient Servant,
Lewis Olrick.

27, Leadenhall-street, November 7, 1871.

To the Editor of Engineering.

Sir,—In reply to Mr. J. McFarlane Gray's letter last week, I have much pleasure in saying that I had misunderstood him in the matter of the deduction of the back pressure, and that consequently we perfectly agree. I was under the impression that he deducted it from the theoretical mean pressure when comparing the actual with it. In his letter of the 19th of October, he said I gave the ratio of expansion without the correction for wire drawing, but I think he would see from mine of the 16th that I had allowed for the wire drawing, and that the two methods of calculating the expansion were the same, the only differences being that in mine the data were nearly all from the actual proportions of the engines, the only data from the cards being the initial pressure, and pressure at point of cut-off in high-pressure cylinders, so that my calculation was only for the designer of the engines, while his taking more from the diagrams could be used by any one, only there was, perhaps, a little more chance of error. For my part I beg to offer my best thanks to Mr. J. McFarlane Gray for the pains he has taken to make the whole matter clear in the simplest and most practical manner.

Mr. Smith is wrong in the construction he puts on my first letter, as its object was to prove the error of calculating the expansion from the initial and terminal pressures, and he has not yet proved himself correct. He knows the ratio of cylinders is only 1 : 3.58, and that consequently the steam leaving the small cylinder has only 3.58 times the space to expand into, so that if it altogether expands 14.8 times it must have expanded 4 times in the high-pressure cylinder, and this it is evident it does not do. If this is not the case then one cubic foot of steam expanding into 3.58 cubic feet of space can expand more than 3.58 times. As Mr. J. Mc Farlane Gray and I are now agreed, I think I cannot do be better than leave the conversion of Mr. Smith in his hands, for if he cannot convert him I fear no one else will either.

I remain yours respectfully,
London, November 8, 1871. J. J. C.

To the Editor of Engineering.

Sir,—Mr. Smith, in his letter, September 29, says, "The coefficient of perfection is, therefore, 3.68, and not 3.154, as Mr. Gray makes it; for the existence of 1½ lb. or any amount of back pressure, is certainly not consistent with perfection." Further, in his letter, October 13, he says, "He takes his theoretical coefficient, and from it obtains the coefficient due after the back pressure is deducted, by taking the effective pressure shown in the diagram, i.e., the pressure of imperfection, instead of the theoretical pressure corresponding to his theoretical coefficient." He therefore substitutes 19.563 as the theoretical pressure corresponding to the theoretical coefficient, instead of 16.167, the effective pressure shown in the diagram. This 19.563, according to his own definition, should be the pressure due to theoretical expansion without deducting "1½ lb. or any amount of back pressure," as to do so would make it "the pressure of imperfection," back pressure being "certainly not consistent with perfection." I have dealt with this part of his letter in this sense as directed by his own words, and without verifying his figures. On examining these now, I discover that he has deducted the back pressure 1½ from the theoretical pressure corresponding to the theoretical coefficient, and that he gives the remainder 19.563 as "the theoretical pressure corresponding to the theoretical coefficient," which he asks to be substituted for the "pressure of imperfection." But if 1½ lb., or any amount of back pressure be inconsistent with perfection, he has in doing this, just substituted one "pressure of imperfection" for another "pressure of imperfection." As I was not prepared for this inconsistency, I understood his figures to be in accordance with his words. Taking them now in the other sense, the following sentence should be substituted for the one in my letter last week. This 19.563 is the sum of the effective pressure, and of the losses represented by x in a preceding paragraph. Mr Smith's correction is that this should have been $\frac{3.398\times(16.167+x)}{16.167+1\frac{1}{2}+x}=3.194$, instead of $\frac{3.398\times16.167}{x+1.25+16.167}=3.154$ when $x=0$.

The object of my letter of September 22, was to point out the inconsistency that existed between the cards and the coefficient 3.32. I assumed the cards to be genuine cards, and meriting a treatment of scrutiny. A coefficient above perfection beyond back pressure was claimed for the working of the engine, and I began by supposing that just such a perfection existed; I first showed that even such perfection in the engines making the cards, would give a coefficient less than the coefficient claimed. I then went on to show that this perfection did not exist, that the measurement of the due terminal pressure 6.125 showed such a hypothesis to be untenable.

Mr. Smith's correction is that I should have constructed the hypothesis of perfection on this measurement, on the measurement that showed such a hypothesis to be untenable. The correction is more remarkable for its simplicity than its logic. I granted this degree of perfection to reconcile the cards with Mr. Smith's high coefficient. Mr. Smith says I should have granted at the same time other cards, cards with 19.563 effective pressure instead of 16.167; the request is certainly an extraordinary one, and yet when he assumes it granted, he can only make out 3.194 as the coefficient instead of 3.32, which he started with. But on the supposition that the engines were working up to perfection, beyond merely the back pressure, how can he make out that the effective pressure was 19.563? He measured it 16.167, and on the supposition that the engines were working with no other loss, he says the effective would be 19.563, that is on the supposition that the engine had no other loss, the effective would have been increased to 19.563; but this can only be on the hypothesis that there were other losses equal to the difference, which is contrary to the hypothesis. It is Mr. Smith's cards and his engine that are under consideration, not ideal cards, but his cards under ideal conditions. I regret that my telegraphed errata were not attended to.

I remain yours, &c.,
J. McFarlane Gray.

[The telegram referred to by Mr. Gray did not arrive until after we had gone to press. The following are the errata in our correspondent's letter of last week: On page 285, middle column, 24 lines from bottom, for ".8320" "read ".8360," and in same column, 22nd line from bottom, for ".5034" read ".5034." On third column, same page, 13th line from top, for "6.70" read "6.10;" and in same column, 44th line from top, for "unintentionally" read "intentionally." Also on page 286, 52nd line from bottom, insert the word "gives" after "This," and in same column, lines 35 and 34 from bottom, "1.25×16.167" and "19.563×1.25" should be "1.25+16 167" and "19.563+1.25" respectively. Also in third column of same page, 12th line from top, for "are" read "is."—Ed. E.]

COMPOUND MARINE ENGINES.

To the Editor of Engineering.

Sir,—I have read several letters in your journal, contributed by Mr. Gray, "J. J. C.," &c., on the above subject. I think Mr. Smith may rest satisfied with the performance of his engines without such an amount of hair-splitting as is indulged in by some of your correspondents in the matter of decimal places, &c. No one will question that the engine builders on the Tyne, Wear, and Tees achieve as good results as any others; and when the "duty" performed by their engines is considered in terms of quantity of cargo carried at an average speed, and under many adverse conditions, I do not think they are equalled either on the Thames, Mersey, or Clyde. I do not propose to write mathematics by the column, but would ask Mr. Smith and others practically engaged in steam navigation, what advantage do we gain by using the compound class of engine at all? I do not see it myself. I admit that when the high pressures were once introduced and surface condensation became a fact (and we should not in the North forget Mr. J. F. Spencer's labours in this field) I admit that to utilise all the old class of low-pressure engines, "compounding" was the only plan, and also that there are hundreds of vessels now afloat which will be requiring new boilers, and I certainly say in that case, substitute high-pressure boilers for their present low-pressure ones, and put high-pressure cylinders on the top of present ones. This is, I think, indisputable, but I cannot myself see what advantage is gained by putting compound engines into a new vessel, and I would among others advance the following arguments in support of my views: I look upon a locomotive as the present most perfect engine, as regards indicated horse power, and work achieved with least dead weight of materials and consumption of fuel. Of course there are exceptionally favourable conditions attached to a locomotive, the high pressure, the use of exhaust steam jet, and great piston speed; but are we not now using 120 lb. per square inch in marine boilers, and we do not get the piston speed, simply for this reason, that we are governed by proportions of stroke and cylinders which were applicable to the old low-pressure class of engine. We cannot very well get the piston speed up by increasing the number of revolutions, without using gearing and this is objectionable, and the working of air and circulating pumps will present difficulties, but not insurmountable ones. But if at present we cannot hope to reach the proud position of the locomotive as regards an immense indicated horse power on very little weight, there is another class of engine which as regards "duty" stands unrivalled, viz., the best class of pumping

engines, where, by using a long stroke, we get the best expansion curve and most work out of the steam raised, and obtain also a good speed of piston with comparatively few revolutions. Now this is in my opinion what we must aim at in our "marine high-pressure engines."

We all know the loss which occurs between the high-pressure and low-pressure cylinders of a compound engine; any apprentice can see that by working out or comparing the diagrams. I do not think any good result is obtained by going into the very minute calculations so ably put forth by Mr. Gray; for so many practical considerations which mathematics have no control over occur, that I think, "simplicity and fewness of working parts," even if on the face of it they show a minute loss, will in the end prove the most economical. For after all a tree is judged by its fruits, not, however, in this case in the sense generally attached to this expression, but I may say by the reduction of its fruitfulness in coal and oil bills. I have always advocated and am not in any way shaken in my faith, that the best form of engine for marine work is a "high-pressure surface condensing engine." To either adopt a long stroke say 4 ft. to 5 ft. and carry the engines up if of the inverted type, or as I should prefer, adopt a modification of a lever engine with a 7 ft. to 8 ft. stroke and the crank reduced to say 2 ft. 6 in. or 3 ft. The steam could then be expanded all in one cylinder, and by due attention to jacketting I am convinced with very good results. By using a proper system of starting valves no difficulty in manœuvring the vessel need be feared, and the shock which many fear from admitting the steam suddenly on the piston exists more in the imagination than in practice.

There are many advantages obtained besides the mere simplicity and better use of the steam. When boilers have been at sea some months, as is well known, the Board of Trade reduce the pressure. Now the "life and soul" of the compound engine is "pressure," for every pound that is taken off, the engine loses its power to do its work in a far more rapid ratio than in the case of high-pressure engines such as I advocate when the difference is spread over two or more cylinders, instead of all being taken off the high pressure. There are no practical difficulties in the way of adopting a long stroke and getting the full benefits of expansion by that means, rather the contrary. The new tonnage rules give us ample room for our engines, and the increased depth of vessels allow us room to get increased diameter of propeller, all of which assist us in designing an engine with long stroke. There is no class of engine which works so economically and so steadily as a well-balanced lever arrangement. If the lever arrangement seems old fashioned or is disapproved of, I think the great depth now given to vessels of the spar decked type leaves nothing to be desired in way of height for an inverted engine. The saving in "wear and tear," the much greater ease with which they can be oiled, &c., by the attendants in heavy weather, all in my opinion favour the abolition of present hope of compound engines, which I said in the first portion of this note can only be looked upon as the best thing to do to an old pair of engines when new boilers at a higher pressure are put in, in preference to putting them out altogether. I shall not enter into any remarks about the boilers. I think, however, that we have reached the limit of thick plates at present, and that some new revolution is pending there also.

Yours truly,
RALPH HART TWEDDELL.

20, Roker-terrace, Sunderland, October 28, 1871.

[Our views respecting the advantages to be derived from compounding differ from Mr. Tweddell's, for reasons which we have pointed out on several occasions.—ED. E.]

WAGES CALCULATOR.

TO THE EDITOR OF ENGINEERING.

SIR,—Now that the nine hours' system is being generally adopted, a great boon will be a good wages calculator. Tegg, Pancras-lane, is the publisher of an excellent one under the 58½ hours' system; perhaps he could get Mr. Walton the inventor to compile another.

We are, Sir, yours obediently,
H. HIND AND SON.

Nottingham, November 4, 1871.

THE STEAM YACHT MIRANDA.

TO THE EDITOR OF ENGINEERING.

SIR,—Might not the upward inclination of the shaft and propeller, as represented by the longitudinal section in your two-page engraving of last week, account for the lifting of the stern which is stated to occur in the case of the steam yacht Miranda, after a speed of about 14 miles per hour has been obtained? Would not the lifting power increase with the increasing horizontal resistance? And might we not expect the same result is worked at half speed, or perhaps less with her stem shackled or fixed? (not above the water line.)

Yours obediently,
J. O. C.

Outram Villa, Weston-super-Mare, November 7, 1871.

[The thrust of the screw of the Miranda is transmitted by the shaft to a point so far forward that it would be incapable of exerting such a lifting force at the stern as "J. O. C." suggests. Moreover, if the screw exerted a lifting power its effect would be noticeable—although, of course, in a less degree—at slower speeds than 14 miles per hour, whereas below that speed the stern of the Miranda is found to dip like that of ordinary screw launches. The alteration in the line of flotation is really due to the altered relative position of the wave caused by the motion of the vessel as we explained last week.—ED. E.]

AMERICAN CITIES.—There are in the United States 409 incorporated cities, the oldest being St. Augustine, Florida, a municipality, however, with but a small population, the census giving it only 1717 inhabitants. The small American cities abound chiefly in the Western States, where it is the fashion to dignify towns of secondary importance by an incorporation.

THE STRENGTH OF STRUTS.

TO THE EDITOR OF ENGINEERING.

SIR,—As a country student of the science of engineering, I have been accustomed to accept with becoming reverence the facts enunciated in the columns of our professional journals. My simple faith has, however, been rudely shaken by a leading article "On the Strength of Struts," which appeared in the last issue of a contemporary of yours, and I apply to you as *amicus curiæ* rather than to the eccentric author of the article, to give me such explanations as may be necessary to relieve me from the pangs of scepticism.

I am in a fog from the very commencement of the article. After stating certain facts as to ties, the writer observes that the case is completely otherwise with those parts "which are acted upon by a strain of the *character normal* to it." Now I hope the question will not be considered of a *character tangent* to a tensile strain or to anything else if I ask respectfully and *radially* what strain it is that is normal to a tensile strain. Is the equation to this *normal*: $y_1 - y = \frac{dx}{dy}(x_1 - x)$, or does it take the more "complicated form" of Mr Charles Mathews's expression for the distance between Hyde Park Corner and the 21st of June? I "want to know you know."

In the succeeding sentence of the editorial I am told that the strength of a pillar "would be directly as the square of its least lateral *dimensions* and inversely as the fourth power of its length." Now I know how to take the square of the least *dimension*, or the sum of the squares, or the product of the least *dimensions*, but I have reluctantly given up all hope of ever emulating the author in the performance of the feat required. I try hard to make *sense* of the passage, but whether I assume that the writer means to say the square of the least dimension or the product of the least dimensions the result is equally ridiculous. In the first case it would follow that the sectional area had nothing to do with the strength, so that a column 1 in. thick by 10 in. wide would be as strong as another 1 in. thick by 10 miles wide, and in the second case it would follow that form had nothing to do with the strength, so that a sheet of drawing paper would stand up on end just as readily when flat as when made up into a roll. But even if I could get rid of these difficulties the "fourth power of the length" would cause me to succumb once more. The writer positively teaches me that in doubling the length of a long column, I reduce its powers of resistance to $\frac{1}{16}$th of the former amount! Now I do not think that it was the author's intention to write comic "copy," so charitably infer that he has been made the victim of one of those practical jokes to which all pretenders are liable. He may, on the other hand, have simply muddled the promptings of a friend and so have converted the *square* of the length into the *fourth* power, and the square of the least dimension *multiplied by the sectional area*, into the "square of the least dimensions."

I am taking up more of your space than the subject justifies, but I cannot refrain from culling one or two more flowers from this wonderful article.

I am told that "in every design, however *correctly proportioned*, a tie will do more work than a strut." I must in future proportion my struts *incorrectly* I suppose, as I usually want them to stand to their work as staunchly as the ties.

In one sentence I find that struts are "supposed theoretically to be free from any tendency to bend," and in the next that "a strut is theoretically weaker than a tie." Both these statements give satisfactory evidence of the exclusive information possessed by the author, as they will be quite novel to *every*body else, and putting the two together I find they are equivalent to the statement that theoretically the resistance of a material to compression is lower than its resistance to tension. Hence a cube of cast iron should crush with 7 tons instead of with seven times 7 tons.

A few lines further on I am told that at 45° the strain is "increased 50 per cent., the increase being proportional to the cosecant of the angle." Hence cosec. 45°=1.5000, although most tables give it as 1.4142; but this is a trifle as compared with fifty other passages that I could quote. The article criticised is not a first offence on the part of the writer; I recognise his fine Roman hand, in perhaps, every alternate issue of the journal favoured by his contributions. Cannot you gag him, and the rest of his tribe?—

"These things that mount the rostrum with a skip,
And then skip down again; pronounce a text;
Cry—Hem! and reading what another wrote
Just fifteen minutes, huddle up their work."

Yours obediently,
O. EVANS.

Pembroke, November 7, 1871.

LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—The ordinary monthly sitting of members took place on the 4th inst. at the City Terminus Hotel, the chair being filled by Mr. Joseph Newton, C.E., president. The attendance was remarkable good, and Mr. Thomas Haughton read a very instructive paper on "The Machinery employed in the Manufacture of Cloth." This was followed by a spirited discussion. Among the new members elected on this occasion, was Mr. Robson, engineer to the Victoria Dock Company.

BRUSH ATTACHMENT FOR ROLLING MILLS.—A wire brush for scratching scale from large round bars during the rolling is in use at the Griswould mill, Troy. The brush is fastened to the rest-bar on the discharging side of the rolls, and the bar passing through the wire is effectually cleaned or freed from all scale by the time it gets the usual number of passes through the finishing groove. It is said that a brush of this kind, the same as frequently used at foundries for cleaning castings, properly arranged behind the rolls, is better than the trough of cinders sometimes used in steel mills, and which is placed behind the rolls in the same position.—*American Artisan.*

STEAM PRESSURE GAUGES.

AT the meeting of the Institution of Mechanical Engineers, held at Birmingham on the 26th ult. there was read a paper "On Steam Pressure Gauges," by Mr. Ernest Spon, of London, communicated through Mr. Charles Cochrane. Of this paper we subjoin an abstract.

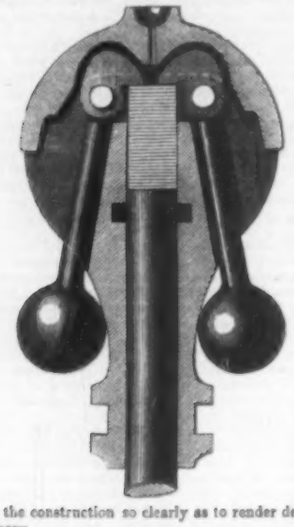
The reliable construction of steam pressure gauges is of much importance in connexion with the safe working of steam boilers, a great number of the spring pressure gauges in ordinary use having been found inaccurate, either from defects in original construction or in consequence of their becoming unreliable when in constant use. In the Bourdon gauge, which is the spring pressure gauge that has been the most extensively used for a great number of years, the indication of the pressure is obtained by the employment of an elastic metallic tube, bent to a curved form, which when subjected to internal pressure becomes less curved; and the resulting movement of the free end of the tube communicates motion to an index upon a dial, through the intervention of a lever or a toothed sector and pinion. The elastic tube, however, is liable to become permanently strained by continued use, or by accidental exposure to an excess of pressure; and the indications of the gauge are then no longer correct. In the Schaeffer gauge the pressure is measured by the deflection of a circular corrugated steel plate, fixed round the circumference and bulged in the centre by the pressure, the extent of the bulging being magnified upon a dial by means of a toothed sector and pinion. This gauge though it has been considered one of the best in use, has a disadvantage in the very small range of deflection of the plate under the pressure, requiring the motion to be very largely magnified upon the dial, whereby any errors are also proportionately magnified. The plate is also liable to be permanently strained by an excess of pressure, and is moreover liable to crack when continually worked. The metal of this plate being very thin, as is also the case with the elastic tube of the previous gauge, its elasticity is liable to be diminished when any oxidation takes place, and error in the indications is then the consequence. The pressure is also measured by the bulging of a circular steel plate in Wallis's gauge, but the deflection is increased by the plate being cut into five segments by radial slits; and a thin brass diaphragm or a sheet of vulcanised india-rubber is used to cover the slits on the side exposed to the pressure. The brass diaphragm, however, is found too rigid to admit of the requisite sensitiveness in the gauge; while the india-rubber is liable to get forced into the slits by the pressure, thereby obstructing the action of the gauge. A solid piston working in a cylinder is supported against the steam pressure by a steel spring in Miller's gauge, and is rendered steam-tight in the cylinder by an india-rubber diaphragm, which is fixed round the circumference between the flanges of the cylinder; the motion of the piston is communicated to the index by means of a short chain, coiled round the spindle of the index, and attached to the arms of a vibrating bow, which is actuated by the piston rod. The motion of the piston is limited to a very short range, owing to the risk of the india-rubber diaphragm getting cut round the edge of the piston with a longer action; and the construction of the multiplying gear for the index involves objectionable complication. In Smith's gauge, which has been extensively used, a steel volute spring is employed, and is acted upon direct by the steam on one side, being covered on that side by an india-rubber diaphragm secured round the circumference to make a steam tight joint. This spring has a considerable range of action compared with the gauges previously noticed, and being of considerable substance is not liable to be affected in strength by corrosion; the deflection of the spring moves the index by means of a rack and pinion. Three concentric spiral springs, placed one within another, with their ends covered by an india-rubber diaphragm, are employed in Silvester's gauge, which is similar in principle to the last one; and the motion is communicated to the index by a rack and pinion. There is, however, an objection to the employment of a rack and pinion for actuating the index of a pressure gauge, on account of the play occurring in toothed gearing; and in Foster's gauge, in which the pressure is measured by the deflection of a volute spring covered by an india-rubber diaphragm as before, the movement of the spring is transferred direct to the index, by means of a stud fixed to the centre of the spring and working in a spiral groove in the spindle of the index. This pressure gauge has been found by the writer to be superior to the other gauges in use, in regard to durability, accuracy, and sensitiveness. The strength of spring employed is proportionate to the limit of pressure to be measured, the total range of deflection being the same in each case. Specimens were exhibited of the various gauges described, and the action of some of them was shown by means of a force pump.

THE NEW RAILWAY AMALGAMATION.—The report of an approaching amalgamation of the Midland with the Glasgow and South-Western Railway Company was confirmed by the posting of the following telegram in the Stock Exchange from the chairmen of the two companies: "The Midland and Glasgow and South-Western directors have agreed to apply to Parliament in the ensuing session for an Act to authorise an amalgamation of their two companies, on terms which secure equal dividends from and after the opening of the Settle and Carlisle line." In Wednesday's *Glasgow Star* we read: "If these companies should succeed in amalgamating their systems, there will be a great through route from Glasgow to London in opposition to that of the North British and Caledonian and London and North-Western Companies' system. The Midland line is now, or will very shortly be, completed from Settle to Carlisle, and it is evident that both companies would enjoy immense advantages through an amalgamation. We much fear that the scheme may meet with opposition from the other large companies interested, but it has a good chance of being successful notwithstanding.

RECENT PATENTS.

The following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 3055, 8d.) William Newzam Nicholson and Edward Lawrence, of Newark, patent the neat arrangement of governor shown by the annexed sketch. The latter will



explain the construction so clearly as to render description unnecessary.

(No. 3054, 1s. 4d.) Richard Brown, of Glasgow, patents the arrangements of blast furnaces, illustrated and described by us on page 391 of our last volume.

(No. 3058, 6d.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of William Henry Downs, of Seneca Falls, U.S., and Jethro Pencille, of Kingston, Canada, arrangements of roller bearings for railway carriages. According to these plans, the axle bears against rollers which revolve on stationary pins and which are provided with recesses for containing lubricating material. We cannot but regard the arrangement as an exceedingly unpromising one, and one which it would be very difficult to apply at all in many instances. The patent drawings show no provision for the play of the bearing springs.

(No. 3067, 10d.) John Henry Johnson, of 47, Lincoln's-inn-fields, patents, as the agent of William Gray Warden, of Philadelphia, U.S., arrangements of vessels fitted with compartments or cells for carrying liquid cargoes in bulk.

(No. 3081, 1s. 2d.) John Penn, junior, and William Hounsell, of Greenwich, patent modes of making curved metal pipes of large diameter. According to these plans, curved troughs, known as "saddles" and "backs," are rolled by means of convex and concave rollers, and are subsequently notched and soldered together to form the pipes. Machinery for carrying out these plans is also included in the patent, and it is probable that we may illustrate it shortly.

(No. 3084, 1s. 4d.) St. John Vincent Day, of Glasgow, patents, as the agent of James Masson and Samuel Hodgert, of Bombay, an arrangement of hydraulic press for pressing cotton, jute, &c. According to this plan, the press is furnished with five or more hydraulic cylinders, the first portion of the compression being effected by the ram of a single cylinder, and the rams of the other cylinders (which are shorter than that first mentioned) being brought into use to complete the process. The patent also includes a particular construction of trunk, with movable sides for containing the materials to be pressed, and forms of fastenings for securing the doors of the press.

(No. 3087, 1s. 4d.) George Haseltine, of Southampton-buildings, patents, as the agent of John Ware Middleton, of Philadelphia, U.S., methods of refining cast iron and manufacturing malleable iron and steel. These plans include such a variety of processes and appliances that it would be impossible for us to give a brief account of them here.

(No. 3099, 1s. 10d.) Thomas Callender Hinde, of Townhope, near Hereford, patents methods of manufacturing iron and steel, which we are also unable to describe here for the reason just stated.

(No. 3104, 6d.) Vitale Domenico de Michele, of Weybridge, patents the neat arrangement of cement and concrete testing machine, illustrated and described by us on page 465 of our tenth volume.

(No. 3110, 8d.) Robert Anthony Hardcastle, of Newcastle-upon-Tyne, patents forms of clips for enabling colliery tubs, &c., to be attached readily to a hauling rope. These clips are so made that they take hold of, and are released from, the rope automatically.

(No. 3123, 10d.) Matthew Burnett, of Spennymoor, patents "condensing" the products of combustion escaping from a steam boiler by surrounding the chimney with a water jacket and by subsequently subjecting the gases to the direct contact of streams of water. In the case of boilers worked in connexion with non-condensing engines, it is proposed to condense the exhaust steam by allowing it to mingle with the products of combustion and then treating the latter as above described. We greatly doubt the novelty of the plans proposed, and still more their utility, unless perhaps in some very exceptional cases.

(No. 3124, 1s. 4d.) William Buck, of Upper Tooting, patents arrangements of locking gear for railway points and signals, which it would be impossible for us to describe briefly.

(No. 3130, 1d.) Henry Bessemer, of Denmark Hill, patents the mode of constructing ordnance, illustrated by us on page 174 of the present volume.

(No. 3131, 1s. 8d.) Fenner Ballou Taylor, of Vowler-street, Walworth-road, patents an arrangement of rock boring machine, the construction of which could scarcely be explained clearly without complete drawings. The machine belongs to the class in which the boring tool derives its motion from a reciprocating piston which is driven by steam or compressed air.

NOTES FROM PARIS.

Paris, Nov. 5, 1871.

The Solidification of Petroleum.

The solidification of petroleum to which we recently referred, is really a true discovery. We have seen at the establishment of a chemist in Paris, samples of the native oil, of the refined oil, and of pieces solidified by the addition of 10 per cent. in weight of another material.

The consistency of the latter samples was almost that of honey or of butter. The preparations made with well purified petroleum are absolutely white, those with less pure oil are more or less brown. The operation of solidification is very simple, and the separation of the foreign substance presents no kind of difficulty. Petroleum in this new condition is still combustible, but when inflamed it does not flow, and fire is not spread with the terrible rapidity which is a characteristic of the burning of petroleum. We have been able to judge by an experiment on a small scale, that this preparation is far less dangerous to transport than the liquid petroleum.

It would naturally follow that the transport would be a less costly matter, and that less care would be required with it. But the practical part of the question has still to be studied, and many more laboratory experiments as well as much industrial experience will be necessary before the hoped for results can be fully realised. It will be needful to ascertain exactly the influence of climate on the material, the mode of mixing and of separation, to find out the most abundant and cheapest material to employ in the solidification, and lastly to ascertain the exact cost.

We shall return to this question when the industrial aspect of the matter is more advanced.

Public Works.

The General Councils recently elected in France have commenced the duties of their first session. A recent law confers on them powers much more extended than they have received under previous *régimes*, and makes these councils the real administrators of the business of the Departments, leaving but little to the prefect nominated by the central power but the duty of executing measures voted by the Council. In particular, for all that which concerns roads other than those known as the grand national routes of general interest, the administration of the routes called departmental, will no longer be intrusted, under the authority of the prefect, to the engineers of the Corps des Ponts et Chaussées. These engineers, recruited from the Polytechnic School, and afterwards trained in the special School of Ponts and Chaussées, form a corps, the general direction of which rests with the Minister of Public Works. Every one acknowledges the talent, the intelligence, the devotion, and the integrity of these engineers; but they have been reproached with not having shown sufficient economy in works which they have constructed, and with a certain amount of administrative obstructiveness.

For these reasons, and for some others, the new law, a law essentially liberal in its spirit, gives to the General Councils the faculty of conferring on some persons whom they consider efficient the construction and the maintenance of the Departmental routes. These clauses in the statute were not voted without considerable discussion. The high merit and the honesty of the Ingénieurs des Ponts et Chaussées have found able and enthusiastic advocates, but the partisans of self-government and of centralisation have carried it by pointing out the aptitude, the experience, and reliability of the road contractors, a class which is charged to occupy itself with all the roads with delay neither to the State, nor to the Department, but to the Commune. They have especially made it apparent that, if the Ingénieurs des Ponts et Chaussées had really possessed a marked superiority over the contractors for the administration of departmental roads, it would not be likely that the Councils, fully appreciating departmental interests, would dream of removing them from functions they fill satisfactorily.

However it may be, the clause was voted and the law is to day in force. For this great inquietude reigns in the Corps des Ponts et Chaussées. The Minister of Public Works has just addressed to the prefect, on the eve of the opening of the session of the Councils, a circular intended to sooth their inquietude, and to soften the blow which strikes at the importance, the existence even of this privileged corps.

The Minister says that if the Councils exercise too freely their power to withdraw from the corps the administration of the departmental routes there will result among these engineers a grave perturbation. He superintends an extent of more than 48,000 kilometres of roads, on which over 30 millions of francs are annually expended, and independently of the engineers themselves, more than 2000 agents or subcontractors are under their direct orders. The minister hopes that the Councils will not wish to risk the disorganisation of the corps without studying in advance the system they propose to adopt.

The circular then examines the principal objections raised against the administration of roads by the Engineers des Ponts et Chaussées. It is pretended that there is no need for men so highly instructed for the maintenance of routes, and that the work intrusted to them costs too much. To the first point it is replied that merit can never be a valid objection; to the second it is affirmed that the accusation of extreme expense has not been proved, and that the dearest roads are the most durable, the most economic to maintain, and the most serviceable.

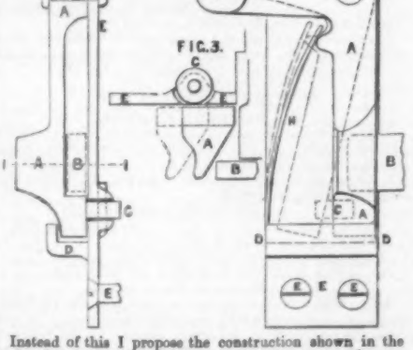
The Ministers demand that the General Councils should carefully appreciate all the elements of the case before making a decision on this important subject, and that those of the Council who wish to preserve the corps should declare their views.

The special situation in which we find the Corps des Ponts et Chaussées is really critical, and causes a certain excitement among the entire body of engineers, for they are divided in France into two distinct classes—the civil engineers and the Government engineers, and these two classes have different interests which are often in opposition to each other.

MORRISON'S DOOR LOCK.

To the Editor of Engineering.

Sir,—I have just seen in your paper a drawing (see page 250 of the number for October 20th) of a new snap-lock for railway carriages which appears to me to be open to the following objections; firstly, its weakness, as it depends entirely upon the axis of the cylinder, which could not well be made more than one-sixth of an inch in diameter, and which when slightly worn would readily give way upon the application of any accidental strain, as it has to support double the pressure that comes upon the door. The joint of the catch which prevents the cylinder from turning is also liable to the same objection. Secondly, its requiring too nice an adjustment, any sideway motion of the door causing it to fail, for if the lock were too long it could not enter the notches in the cylinder, and if too short it would strike the circumference of the cylinder instead of catching in the notch, and so, failing to turn the cylinder, leave the door unfastened.



Instead of this I propose the construction shown in the enclosed diagram, of which you are at liberty to make any use you please. In the sketch Fig. 1 is a side elevation; Fig. 2 a front elevation; and Fig. 3 a sectional plan showing the door in the act of shutting. A A, is a movable piece working on rivet G; B, tongue of door lock; C, friction roller; D, restraining piece; E E, attachment plate and screws; and F, counterpoise rendering it independent of the spring H.

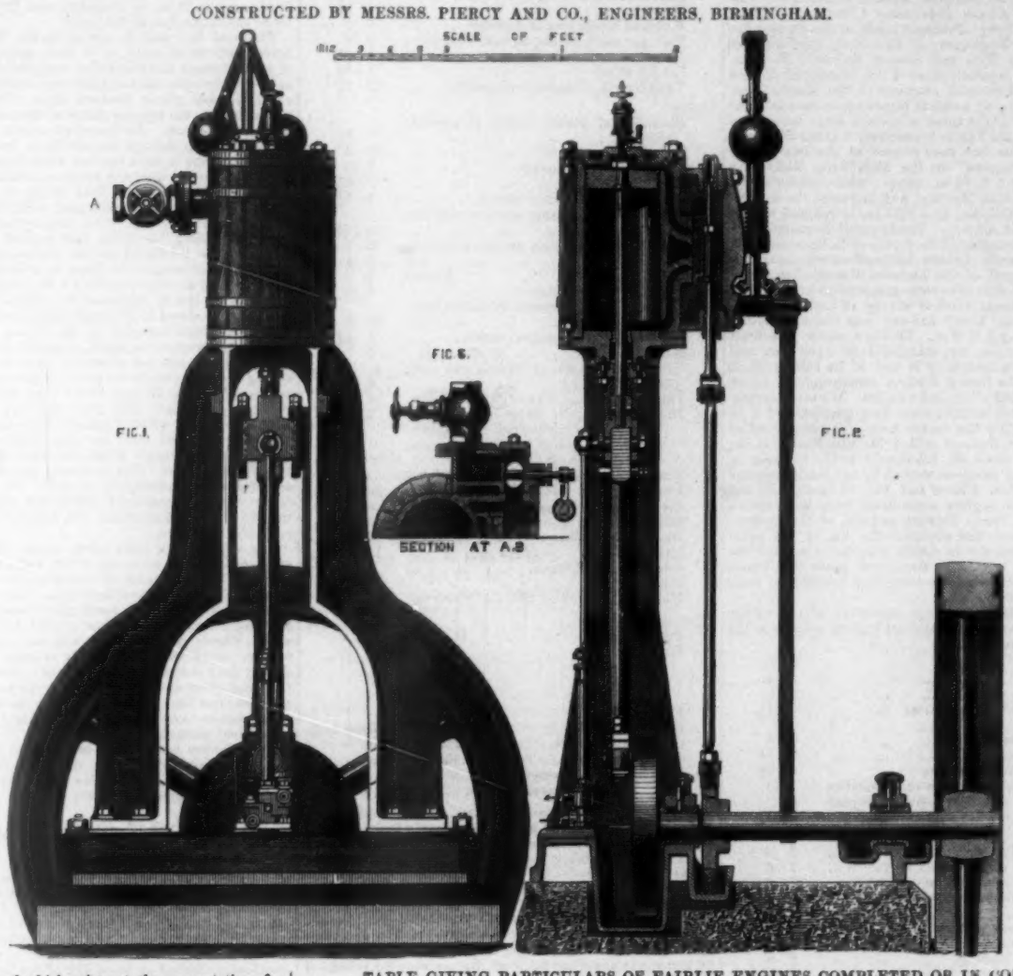
Yours, &c.,

October 26, 1871. A. B.

[We publish our correspondent's letter and the sketch which accompanies it; but we must point out that he is in error in supposing that the pin which traverses the cylinder of Mr. Morrison's lock "could not well be made more than ⅛ in. in diameter." The fact is that it may be made of any desired diameter simply by increasing the diameter of the cylinder and the number of grooves or notches in that cylinder. The joint of the detent may also be strengthened to any desired extent, while an increase in the size of the cylinder would also enable the size and form of the notches to be modified so as to give the tongue of the lock greater hold. The arrangement proposed by "A. B." is open to the same objections as many spring latches previously proposed, viz., that if the spring is made stiff enough to secure prompt action, the door does not close easily, and if on the other hand the spring is so proportioned as to enable the latch to yield easily, the return of the movable piece is not so prompt as is desirable in a lock for a railway carriage door. —Ed. E.]

VERTICAL ENGINE.

CONSTRUCTED BY MESSRS. PIERCY AND CO., ENGINEERS, BIRMINGHAM.



THE great demand which exists at the present time for steam engines of small power has caused a number of firms to design special types of such engines capable of being constructed at prices which but a few years ago would have been considered absurdly low. We have on several occasions illustrated examples of the class of engines to which we have just referred, and we now publish engravings showing another, and very good and compact type, designed by Messrs. Piercy and Company, of the Minerva Works, Islington, Birmingham. Messrs. Piercy's engines are of the vertical, inverted cylinder class, the cylinder, valve chest, lower cylinder cover, crosshead guides, and vertical frames being, in the case of engines of four horse power, and under, all cast in one piece. This does away with a steam-tight joint and enables the cylinder, lower cylinder cover, and guides to be bored out at the same time, thus saving labour besides insuring perfect accuracy. In the larger engines, there is one joint between the cylinder and lower cover, (as shown in our engravings, which are made from drawings of a 6-horse engine) the construction being in other respects similar to that of the smaller sizes. The governor is of simple form and its slide has grooves formed in it which are geared into by a toothed quadrant keyed on the throttle valve spindles as shown in the figures. The throttle valve itself is accessible by simply removing a screwed cap (*see* Fig. 3) without interfering with the steam pipe.

The bed-plate is a substantial casting and the crank shaft bearings are recessed into it so that the shaft itself is kept close to the ground. Both the crank shaft bearings are carried by the bed-plate, so that the engine is quite self-contained and can be fixed on a wooden floor by four bolts. The cross head is of wrought iron and is fitted with shoes tightened up by screw wedges. The piston is fitted with three of Ramsbottom's rings, and the slide valve has sufficient lap to cut off the steam at about three-fourths of the stroke. The feed-pump is worked direct from the crosshead as shown in the figures. The remaining features of the design—which is exceedingly neat and good throughout—are so clearly shown by our engravings that further description will be unnecessary. We may add, however, that these engines are well adapted for export purposes, there being but few parts and it being impossible to put these parts together in any but the right way. Messrs. Piercy make the engines we have described of sizes varying from 3½ in. cylinder with 6 in. stroke, to 10½ in. cylinder with 18 in. stroke, the particular engine shown by our engraving having an 8 in. cylinder with 14 in. stroke, and being, as we have stated, rated by the makers at 6-horse power.

TABLE GIVING PARTICULARS OF FAIRLIE ENGINES COMPLETED OR IN COURSE OF CONSTRUCTION; OCTOBER, 1871.—(*See next page.*)

Reference Number.	Name of Railway for which the Engines are Constructed.	Gauge of line.	Cylinders.			Wheels.		Heating surface.			Capacity of bunkers for coal.	Capacity of bunkers for wood.	Capacity of tanks.	Weight in working order.	Number ordered.	Number delivered.	Number in hand.
			Diameter.	Stroke.	Number.	Diameter.	Number.	Fireboz.	Tubes.	Total.							
		ft. in.	in.	in.	No.	ft. in.	No.	sq. feet.	sq. feet.	sq. feet.	cub. feet.	cub. feet.	gal.	tons			
1	Festiniog Railway	1 11½	8½	15	4	2 4	8	60	670	730	40	...	800	19½	1	1	
2	Peru Narrow-Gauge Railway	2 6	10	18	4	3 3	8	70	762	832	40	...	900	...	2	...	2
3	Glasgow and Cape Breton Railway, Nova Scotia	3 0	11	19	4	3 3	8	85	815	900	56	...	1080	...	4	...	4
4	Imperial Livny Narrow-Gauge Railway, Russia	3 6	13½	18	4	3 3	12	115	1210	1325	...	200	1250	42	5	5	
5	Toronto, Gray, and Bruce Railway, Canada	3 6	11½	18	4	3 3	8	102	850	952	...	150	1000	...	2	...	2
6	Port Chalmers and Dunedin Railway, New Zealand	3 6	10	18	4	3 9	8	70	762	832	40	...	900	...	3	...	2
7	Rio de Janeiro Railway	1.1 metre = 3 ft. 7.3 in.	12	24	4	4 3	8	98	980	1078	60	...	1060	...	1	...	1
8	Bury Port and Gwendreath Valley Railway	4 8½	10	18	4	3 6	8	70	763	833	50	...	900	...	1	1	
9	Nassjo and Oscarsham Railway, Sweden	4 8½	10	18	4	3 6	8	70	763	833	50	...	900	...	5	1	4
10	La Vendée Railway, France	4 8½	10	18	4	3 6	8	70	763	833	50	...	900	...	1	1	
11	The "Janus," made by Messrs Mason, Baltimore, U.S.A.	4 8½	15	22	4	3 6	12	136	1540	1676	...	...	2000	...	1	1	
12	Iquiqui Railway, Peru	4 8½	15	20	4	3 6	12	130	1470	1600	80	...	2200	...	4	2	2
13	Pesagno Railway, Peru	4 8½	15	22	4	3 6	12	135	1550	1685	80	...	2260	...	5	...	5
14	Mexican Railway, Mexico	4 8½	15	22	4	3 6	12	135	1550	1685	80	250	2300	...	8	1	7
15	Swiss Railway	4 8½	12½	20	4	3 9	8	102	1050	1152	60	...	1300	...	2	...	2
16	"	4 8½	13	22	4	3 6	12	140	1600	1740	80	...	2000	...	1	...	1
17	Tamboff-Saratoff Railway, Russia	5 0	15	20	4	3 6	12	130	1450	1580	...	343	1800	...	10	4	6
18	Poti and Tiflis Railway, Russia	5 0	15	22	4	3 6	12	135	1550	1685	80	250	2200	...	8	1	7
19	Great Southern and Western Railway of Ireland	5 3	15	20	2	5 7½	4	75	663	738	60	...	900	...	2	2	
														Totals...	66	20	45

NOTE.—All the engines mentioned in the above, with the exception of No. 19, are constructed with double boilers and double steam bogies. No. 19, however, has a single boiler of the ordinary pattern, and is fitted with but one steam bogie, the other bogie, which is situated at the trailing end, being without cylinders, and being constructed on Mr. William Adams's plan. We illustrated this engine in our number for March 18, 1870.

NEW YORK VIADUCT RAILWAY.—The municipal troubles of New York have interfered with the projected New York Viaduct Railway. The supplies have been stopped, and the directors have ceased to meet for the present.

LOCOMOTIVES FOR THE INTERCOLONIAL.—The Intercolonial Railway commissioners are doing what they can to encourage Nova Scotian industry. Mr. Montgomery, of Freshwater, Halifax, is building thirty locomotives for the line.

LOCOMOTIVE FOR THE LIVNY RAILWAY.

In February last an Imperial Russian Commission, consisting of Count Alexis Bobrinskoy (President); Count Zamoyski; Count Berg; Professor Saloff, of the Russian Institute of Imperial Engineers; M. Rocheberg, chief engineer and manager of the Nigo and Moscow Railway; M. Schuberski, locomotive superintendent of the Woronesch-Roston Railway; and M. Kivisnski, inspector of the Karchof-Crementchur Railway, paid a visit of inspection to the celebrated Festiniog line, and whilst there witnessed some interesting experiments* with the Fairlie locomotive, "Little Wonder." A few days later also they were present at the trial of the Fairlie engine, "Progress" on the Mid-Wales Railway, a line of the ordinary 4 ft. 8½ in. gauge; while, subsequently, the Commission visited Norway, and inspected the narrow-gauge railways which Mr. Carl Pihl has introduced with so much success in that country. The Imperial Commission investigated most thoroughly all the details of the lines examined by them, and the result of these deliberations was the recommendation on the part of the Imperial Commission of the construction of a system of narrow-gauge railways in Russia; and, with a promptness which is worthy of notice, in May last year the Imperial Livny Railway was commenced, the gauge adopted being 3 ft. 6 in. This line, which is a little over 38 miles in length, was completed in April last, and many interesting particulars of it and of its rolling stock were given in a letter from a Russian correspondent, which appeared on page 292 of our last number. We may mention here, however, that it includes some long gradients of 1 in 80 and 1 in 100, while the curves have a minimum radius of 10 chains. The line—of which M. von Desen is the resident engineer, while M. Schuberski is the engineer in charge of the rolling stock—is worked by two tender engines constructed by Messrs. Kitson and Co., of Leeds, and five double-bogie Fairlie engines constructed from Mr. Fairlie's designs by Messrs. Sharp, Stewart, and Co., of Manchester; and the success which has attended the use of the latter engines, and the manner in which they have enabled the capabilities of the line to be developed, prove that Count Brobrinskoy and his colleagues were fully justified in their adoption of the Fairlie system.

We give this week a two-page engraving of one of the double-bogie engines just referred to, and we subjoin a list of the principal dimensions:

	ft.	in.
Cylinders:		
Diameter	1	1
Stroke	1	6
Distance apart beween centres	5	1½
Number 4		
Length of ports	0	9
Width of steam ports	0	1½
„ exhaust ports	0	2½
Distance between centres of valve spindles	1	10
Distance from centre-line of exhaust port to centre of driving axle	10	4½
Wheels and axles:		
Diameter of wheels	2	3
Wheel base of each bogie	7	6
Total wheel base of engine	27	6
Diameter of axle bearings	0	4½
Length „ „	0	7
Distance between centres of bearings	2	8
Diameter of driving crank pin at connecting rod bearing	0	2
Length of connecting rod bearing	0	3
Diameter of driving crank pin at coupling rod bearing	0	3½
Length of coupling rod bearing	0	2½
Central wheels; diameter of crank-pin bearings	0	2½
Central wheels; length of crank-pin bearings	0	2½
Leading wheels; diameter of crank-pin bearings	0	2½
Leading wheels; length of crank-pin bearings	0	2½
Gear:		
Length of connecting rods between centres	7	2
Diameter of piston rods	0	2
Width of guide bars	0	4
Length of crosshead blocks	0	10
Diameter of eccentrics	1	1
Width „	0	2½
Travel „	0	5½
Length of eccentric rods between centres	5	2
„ expansion link „ „	1	2
„ (total) of valve rod „ „	3	8
„ of valve rod between centre of block in expansion link and point of attachment of lifting link	0	5½
Distance from centre of driving axle to centre of weigh bar	5	4½
Height of centre line of weigh bar above centre line of motion	1	0
Length of lifting links	1	0
Length of lifting arm for expansion link	0	2½
„ „ „ valve rod	0	5½
Frames:		
Distance apart of bogie frames	3	0
Thickness of bogie frames	0	½
Depth of bogie frames at cylinders	2	9
„ „ hornplates	2	3½
„ „ above axle boxes	1	9½
Length of each bogie over buffer beams	14	11
Radius of inner end of each bogie	5	10½
Height of top of bogie frames above rail	3	3
Distance between centres of bogies	20	0
Distance apart of upper or carrier frames	3	8½
Thickness of „ „ „	0	0½
Depth „ „ „	0	9½
Width of bogies over foot-plates	6	9
Extreme width of engine over foot-plate	8	10
Height of main foot-plate above rail level	3	7½
Length of cab	8	2½
Total length of engine over buffers	42	1½
Boiler:		
Diameter of barrels inside at smallest plate	3	3½
Length of each barrel	10	6
Length of firebox casing	7	10
Width „	3	6½
Radius of top of firebox casing	1	9½
Depth of firebox casing below centre line of boiler	4	0½
Length of each firebox, inside, at bottom	3	6
„ „ top	3	4
Width „ „ bottom	3	0
Height of inside fireboxes	4	5
Length of boiler between smokebox tube-plates	28	10
Diameter of steam domes, inside	1	5½
Height „ „ above barrel	2	9
Thickness of plates of barrels and sides of firebox casing	0	0½
Thickness of end plates of firebox casing	0	0⅝
Thickness of copper plates of fireboxes... [With the exception of tube plates, which are ½ in. at the upper portion, and 7/16 in. thick below.]	0	0½
Number of tubes in each barrel 123		
Length „ between tube plates	10	0½
Diameter „ (outside)	0	1¾
Pitch „ „	0	2½
Diameter of chimneys	1	1
Height „ above rails	12	8½
Length of smokeboxes	2	4
Diameter „ „	3	11
Height of centre line of boiler above rail	5	4

Heating surfaces:	
Tubes	1210 eq. ft.
Firebox	115 „
Total	1325 „
Firegrate area	21 „
Pressure of steam	140 lb. per square inch.
Space for fuel	200 cubic feet.
Contents of tanks	1250 gallons.
Weight of engine empty	35½ tons.
„ „ in working order	46 „

Referring to the engravings, it will be seen that the engines are of Mr. Fairlie's ordinary double-boiler double-bogie type, with such modifications as were required to adapt them for burning wood fuel, and with such improvements in the details of construction as experience has suggested. One point in which the Livny engines differ from those previously built on the Fairlie system consists in the arrangement of the centre pins for the bogies. Referring to the views we publish, it will be seen that the frames of each bogie are strongly braced together by transverse and diagonal plate frames near the middle of their length, these transverse frames supporting a cast-steel socket, in which the brass centre pin fixed to the boiler rests. These centre pins are each 12 in. in diameter, and are made with flat ends. The whole weight of the boiler does not rest on these pins, however, each of the latter being supplemented by two segmental blocks, which bear on a plate carried by the transverse frames already mentioned, and which are guided by curved angle irons forming slides, as shown in the plan. Each of the segmental blocks is 4½ in. wide by about 2 ft. long, measured along its centre line, the latter having a radius of 2 ft. 4½ in. A large and widely-spread bearing surface is obtained in this way, while, at the same time, the bogies are left free to swivel under the boiler.

As in all Mr. Fairlie's later engines, the boiler is supported by carrier frames, to which the bogie pins are fixed, and which form a kind of cradle in which the boiler lies. Across each end of the firebox casing is carried a strong transverse stay, built up of plates and angle irons, and to each of these stays the adjacent bogie is connected by a pin passing through india-rubber check springs, as shown in the longitudinal section. These springs serve to steady the bogies, but at the same time leave them free to pivot on their centres, each of the pins which traverse the springs passing through a segmental slot in a plate forming part of the bogie frame, and this slot being sufficiently long to allow of a movement of 7 ft. in either direction.

The carrier frames, besides connecting the bogie pins, and thus taking the longitudinal strain, support the tanks, of which there are six in all, namely, one on each side of each barrel of the boiler, and one on each side of the firebox casing beneath the footplate. The former tanks are each 8 ft. 9 in. long, by 1 ft. 9 in. wide, and 2 ft. 7 in. deep; while the latter are each 8 ft. 2½ in. long, by 1 ft. 9 in. wide, and 1 ft. 11 in. deep. Their net capacity is, as we have already stated, 1250 gallons.

The steam pipes from the boiler are connected to the cylinders by the arrangement of sliding and ball and socket joints, clearly shown in the longitudinal section and plan. Similar joints are also used to couple up the exhaust pipes, as shown. It will be seen that in these joints each ball on the coupling pipes is surrounded by two cut brass rings, which can be tightened upon the ball by screwing up an external ring tapered internally. As now made, these joints stand well, and the experience gained on the Festiniog Railway, where similar joints have been in use for some time, goes to show that no trouble need be apprehended from them. The engines we are describing, we should mention, are fitted with an arrangement of variable exhaust, this consisting simply of a short conical nozzle capable of being raised or lowered within the ordinary fixed nozzle. The fixed nozzle is 3½ in. in diameter, and its top is 1 ft. 6 in. above the centre line of the boiler.

The wood fuel used is carried on the top of each boiler barrel, each barrel being, as it were, arched over by a kind of screen formed of a number of longitudinal bars placed so as to overlap each other slightly, and rivetted together with small distance pieces between them. These screens are placed outside the lagging plates of the boiler, and on them the wood fuel rests. Air heated by contact with the lagging plates passes up through the interstices between the screen bars, and serves to thaw the fuel when frozen, or dry it when wet. At the same time any moisture which may drain down from the fuel is prevented from falling on the boiler by the fact of the screen bars overlapping each other, and it is thus carried off on either side. This arrangement of screen bars or "chain plating," as it has been termed, was specially designed by Mr. Fairlie for use on engines which are liable to have wood fuel supplied to them in a damp or frozen state, and it appears admirably suited for its purpose. At the sides and ends the fuel is supported by a trellis work of 1 in. by 1/16 in. bars as shown in the longitudinal section and plan.

The footplates occupied by the driver and fireman are completely protected by a cab, as shown, this cab being provided with side and end windows; while it is also fitted with sliding doors (shown in the plan) by means of which access can be obtained to the tops of the wing tanks, and thence to the bogie platforms. The men can thus pass from end to end of the engine without going outside the handrail plates. The firebox is fired from one side, while at the other side are sight holes through which the state of the fire can be seen by the driver. The reversing gear of both bogies is actuated simultaneously by a screw and hand wheels, as shown, while the regulator valves, for admitting steam to the two sets of cylinders are also actuated by a single lever conveniently placed.

The engines have brass tubes, copper fireboxes, and the axles, tyres, piston rods, axle boxes, and axle box guides are of steel. The pistons are of wrought iron, and are of a light form, as shown in the sectional plan. The engines are fitted with central buffers and couplings arranged as shown in our engravings. Brakes are applied to the driving and central wheels of each bogie, and the engines are also, we believe, fitted with Chatelier's counter pressure brake, already fully described in our pages. The workmanship of the locomotives we are describing is—as we had occasion to mention some time ago when noticing the trial of the first of these engines completed by Messrs. Sharp, Stewart, and Co.—excellent throughout.

The cylinders being 13 in. in diameter by 18 in. stroke, and the wheels 3 ft. 3 in. in diameter, the tractive force which these engines are capable of exerting for each pound of effective pressure per square inch on the four pistons will be:

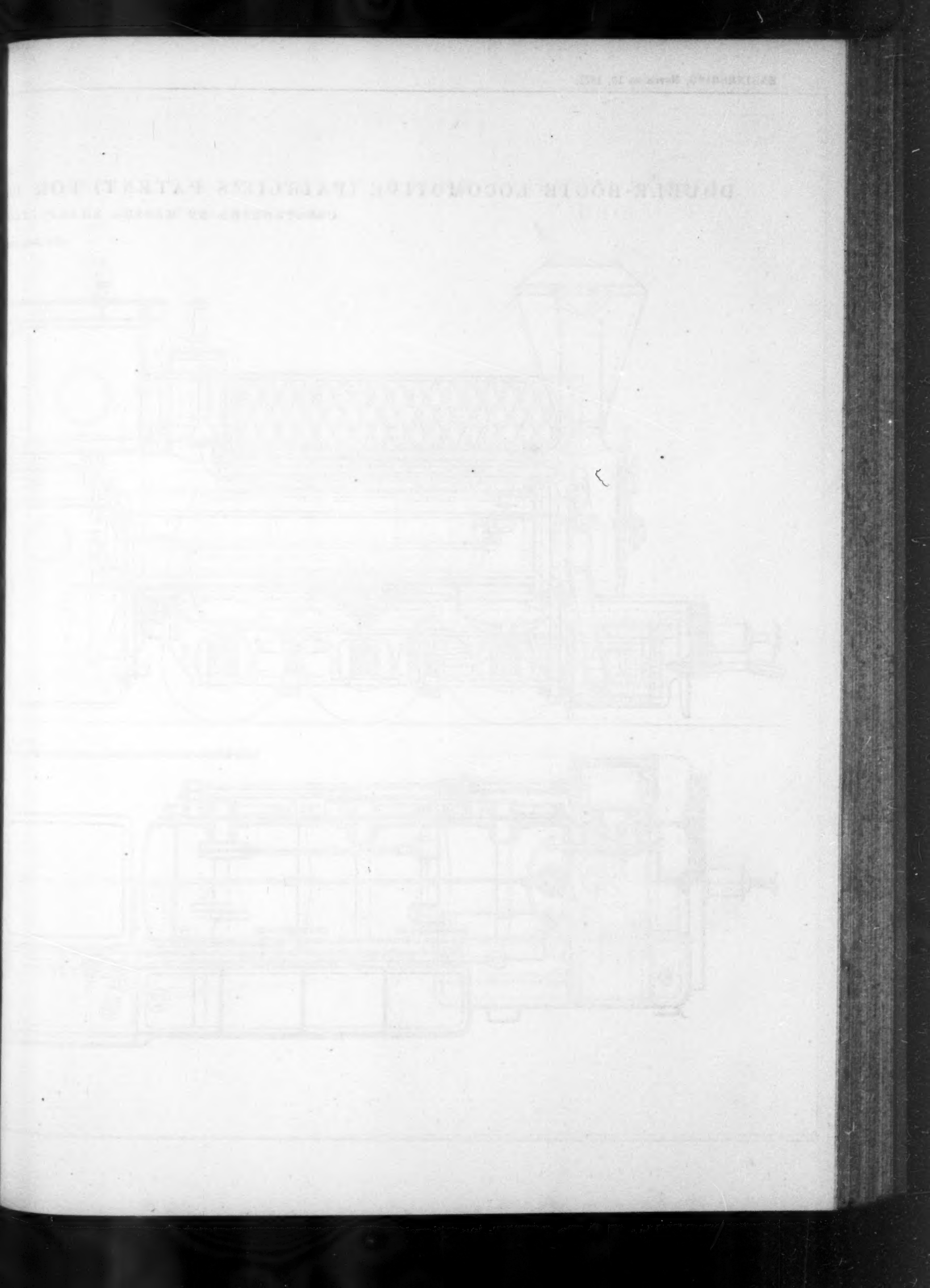
$$\frac{13^2\times18\times2}{39}=\frac{169\times18\times2}{39}=156\text{ lb.}$$

With steam at 140 lb. per square inch in the boiler an effective pressure of at least 100 lb. per square inch should be maintained in the cylinders, and this would give a tractive force of 15,600, or, say, about 7 tons. The weight of the engine in working order being almost 46 tons, there will be ample adhesion to enable this great cylinder power to be utilised. It was stated in the letter of a Russian correspondent, published on page 292 of our last number, and to which we have already referred, that the greatest load drawn over the Livny Railway by one of these engines up to the present time is one composed of 61 goods' wagons, containing 288 tons of net load, the total gross weight of the train being 400 tons, and its length, exclusive of the engine, 896 ft. That such a train can be successfully hauled by a Fairlie engine over a line of 3 ft. 6 in. gauge is a convincing proof of the capabilities of such lines when worked on Mr. Fairlie's system, and Count Brobrinskoy and his colleagues deserve great praise for the able manner in which they have brought that system to the test of actual practice.

We have on numerous occasions received inquiries as to the number of Fairlie engines in use, and the lines on which they are employed, and this has induced us to append to the present notice (see preceding page) a Table giving the leading particulars built or ordered up to the last month. Since that date several others have, we believe, been ordered, but respecting these we have not yet received detailed information. The Table to which we refer, will, we think, be regarded with much interest by a large number of our readers.

* See page 121 of our ninth volume for particulars of these trials.

ENGINEERING SOCIETY, KING'S COLLEGE.—At the last general meeting of this society, held on Friday, November 3, Mr. Hunter, president, in the chair, a paper was read by Mr. Terry "On the History of the Steam Engine." The author commented briefly on the knowledge of the ancients of the expansive force of steam, as mentioned in Hero's "Spiritalia sero Pneumatica." He dwelt lightly on the various rumours of steam-moved mechanism until the time of the Marquis of Worcester, of whose water-commanding engine he gave a description. He then described Savery's application of the condenser, whereby much better results were attained, and Newcomin's use of the cylinder and jet condenser, which made the height of lift independent of boiler pressure, the invention of self-acting valve gear by Humphry Potter, and the improvements in detail effected by Smeaton. He then dwelt at length on the vast inventions of Watt, such as the separate condenser, parallel motion, crank, sun and planet wheels, and the governor, mentioning briefly his discovery of the principle of expansion, the invention of the indicator, and a few others of the countless improvements effected by Watt, which practically bring the beam engine up to its condition of efficiency at the present day. The author then said a few words on the character of Watt, and of his many virtues, and on what may be learnt from the "History of the Steam Engine," and of those connected with it. The time being short, he was unable to speak on the marine or locomotive engine.



DOUBLE-BOGIE LOCOMOTIVE (FAIRLIE'S PATENT) FOR T

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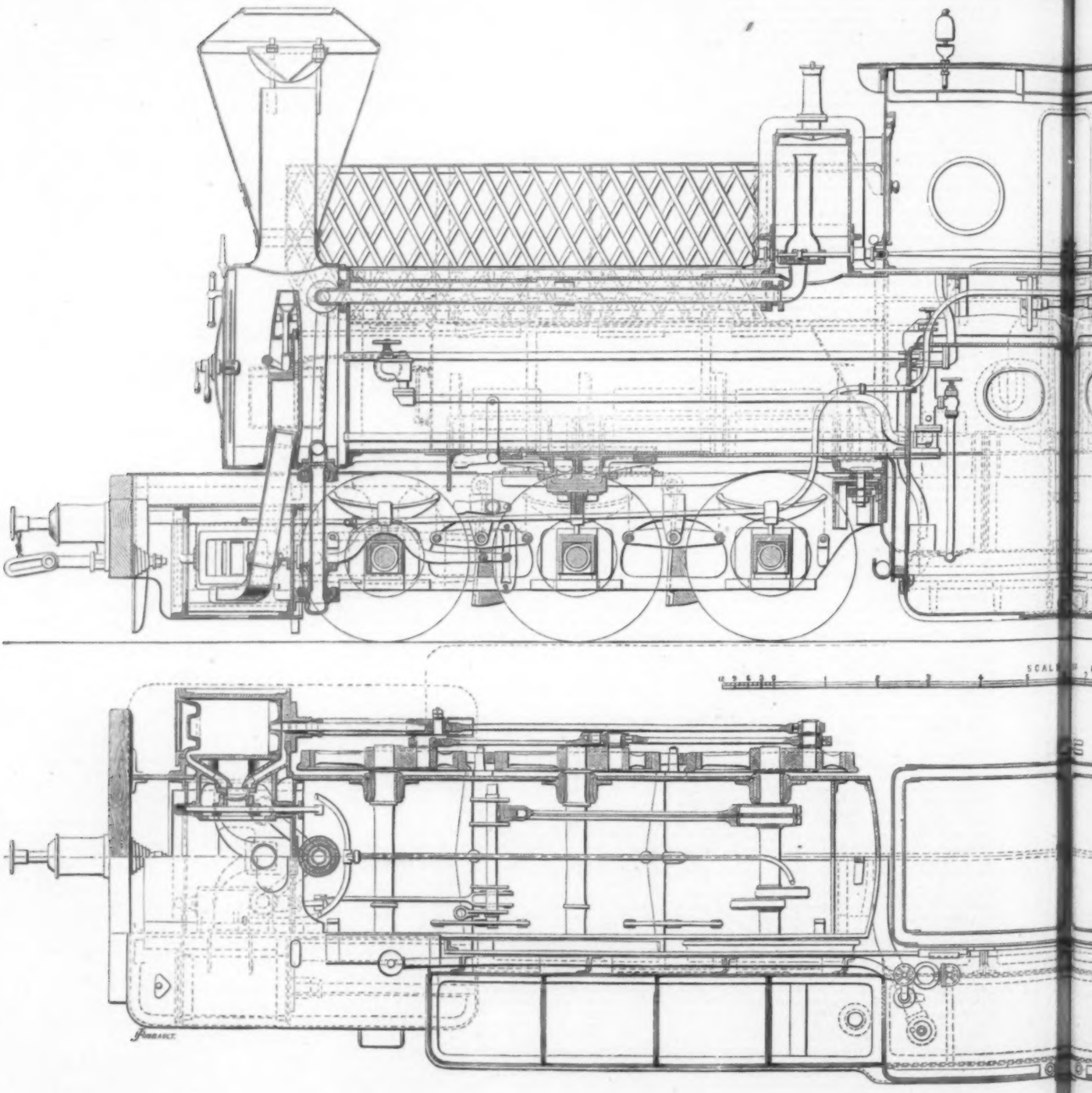
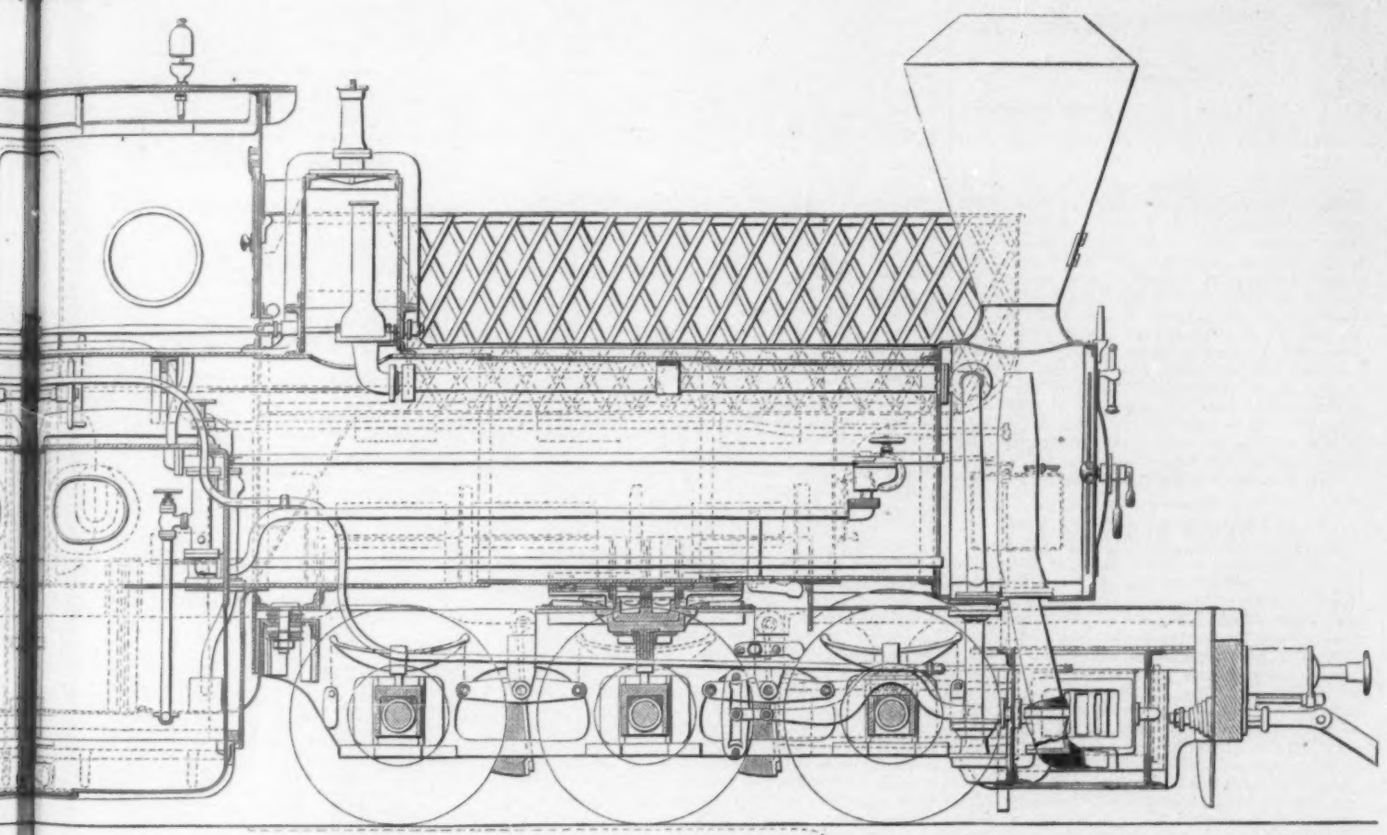
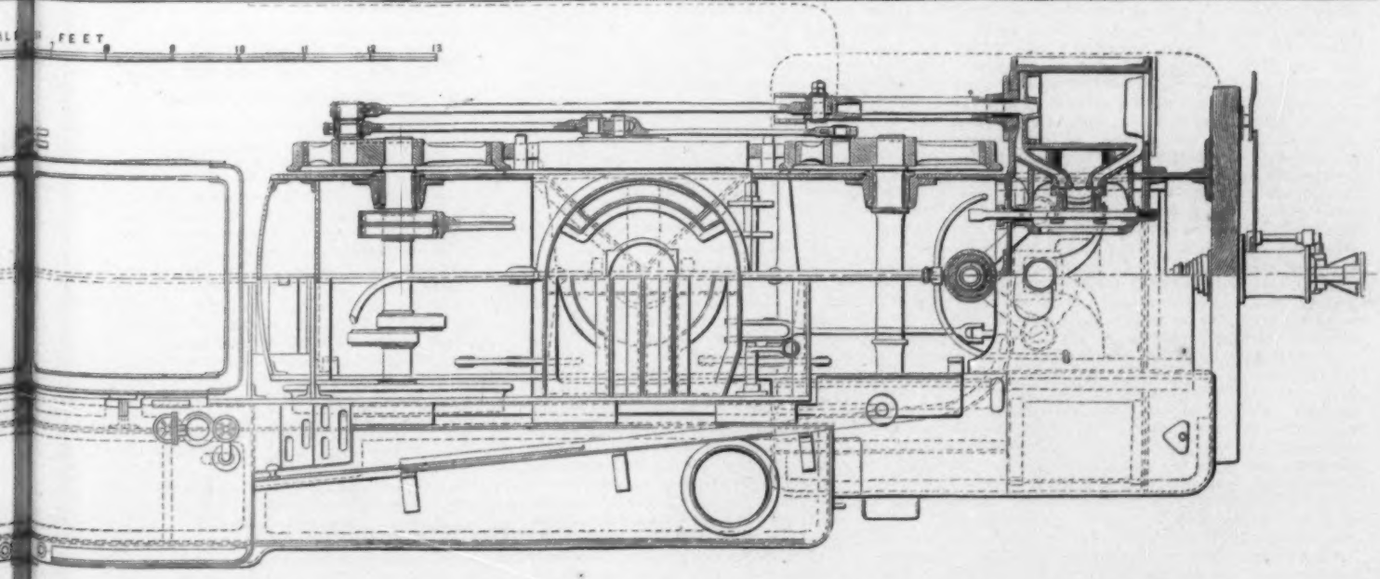


THE IMPERIAL LIVNY NARROW GAUGE RAILWAY, RUSSIA.

BEYER, PEACOCK AND CO., ENGINEERS, MANCHESTER.

(Description Page 304.)





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NOTICE OF NEXT MEETING.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, November 14, at 8 p.m. "Pneumatic Despatch Tubes; the Circuit System." By Mr. Carl Siemens, M. Inst. C.E.

THE "ENGINEERING" DIRECTORY is published this week on the thirteenth page of our advertisement sheet.

NOTICE TO AMERICAN SUBSCRIBERS.

In consequence of the great increase in our American connexion, we have found it necessary to establish a branch office in the United States. Communications may in future be addressed to MR. GEORGE EDWARD HARDING, C.E., *of* 176, *Broadway, New York, who is our accredited representative.*

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of* 1*l.* 14*s.* 8*d.* ($8.32, *gold*) *per annum, payable in advance.*

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ENGINEERING.

FRIDAY, NOVEMBER 10, 1871.

LOCOMOTIVE WORKING EXPENDITURE.

IT is but a short time since* we directed attention to the somewhat abnormal position which a locomotive occupies amongst steam engines generally as regards the small opportunities it affords for being worked with a greater economy of fuel. A locomotive with its imperfectly protected and unjacketted cylinders, placed in a position which facilitates the carrying into them by the steam of any water mixed with the latter, cannot be declared a high class type of steam engine; but it is nevertheless a type which has done good service, and it is, moreover, one which it is difficult to modify with any really economical result under the circumstances which govern locomotive working. As we pointed out in our former article, the great obstacle to the improvemant of the locomotive engine as a steam user is the small number of hours per annum during which such an engine is actually working. This small proportion of working time limits the annual monetary saving which any given improvement can effect, and renders the charge for interest on the additional cost of any such improvements disproportionately large. Taking the mean gross cost of an engine as 2400*l.*, and the mean annual cost of fuel as 180*l.* per annum we showed, on the occasion to which we have referred, that even if by doubling the cost of an engine, it was possible to save the whole cost of fuel without incurring any extra charges for depreciation and repairs, the saving would but pay interest at the rate of 7½ per cwt. per annum on the extra outlay. The sum above taken as the annual cost of fuel per engine, namely, 180*l.*, was deduced from an examination of the accounts of ten of the principal English railway companies for the last half year of 1870; but we this week publish on page 310 a Table giving a more complete account of the expenditure on twenty of our principal lines which will enable us to found our deductions on a broader basis.

The Table referred to—which, we believe, will be regarded with much interest by a large section of our readers—contains data derived from the locomotive accounts of the various railways enumerated for the first six months of the present year, and from it we find that the average cost of fuel per engine during that period was 72*l.*, or at the rate of but 142*l.* per engine per annum. Now, if we assume, as we may justly do, that any improvement made in a steam engine should pay, on an average, at least 15 per cent. per annum (5 per cent. for interest on capital, and 10 per cent. for depreciation) on its original extra cost before it can be regarded as being a source of economy, we find that any improvement capable of saving 10 per cent. of the fuel used, must, if applied to a locomotive, cost less than 100*l.*, or that otherwise such an improvement will not prove really an economical one. This deduction agrees with that made in our former article, namely, "that any fuel-saving appliances added to a locomotive must, to avoid their use being attended with a loss, effect on the average a reduction of fuel amounting to 1 per cent. for each 10*l.* of their original cost." This, it must be borne in mind, is an average result, and it is one also applicable to individual lines of great extent and variety of traffic, such as those of the London and North-Western, Great Northern, and similar companies. But although this is the case, a closer investigation of the Table shows us that there are certain lines on which the conditions of working are so exceptional that the above deductions entirely cease to be applicable. This, for instance, is the case with the North London Railway, where the cost of fuel per annum is 264*l.* per engine, or nearly double the average, and still more noticeably so in the case of the Metropolitan Railway, where the annual cost of fuel per engine rises to 528*l.*, a sum more than seven times the average, and more than ten times that incurred per engine per annum on the London and North-Western Railway. The effect of this on the expenditure which it is justifiable to make on fuel-saving improvements is very striking, and, in fact, it will be seen that, whereas, on the average, any improvements which are capable of saving 10 per cent. of fuel should not cost more than 100*l.* per engine, in the case of the Metropolitan Railway such an improvement might be profitably employed even if it increased the cost of each engine by 700*l.* In making this statement we are, of course, supposing that the improvement is of such a character that its maintenance would not involve an annual charge greater than 10 per cent. on its original cost. In the same way we find that on the North London line an additional expenditure of about 190*l.* per engine, would be justifiable for the purpose of obtaining a reduction of 10 per cent. in the consumption of fuel, and a similar statement would apply to the London, Brighton, and South Coast Railway. In the case of the Metropolitan Railway the high cost of fuel per engine per annum is due partly to the high price of the superior kind of coke which it is necessary to employ on that line, partly to the heavy work to be done, and partly to the great mileage obtained from the engines. This mileage, it will be noticed, is more than 80 per cent. in excess of the average, and is nearly 8000 miles per annum greater than it is on any other line in the country. The causes we have above enumerated place the Metropolitan Railway in quite an exceptional position, and afford opportunities for the employment on it of economical expedients which would be inadmissible on other railways.

Turning now to the data given in the Table concerning the expenditure on oil, tallow, &c., we find the average annual cost per engine for these materials to be 32*l.* Applying the same rule as before, namely, that any improvement must effect an annual saving equal to at least 15 per cent. on its original cost, we find the average maximum justifiable expenditure to be about 2*l.* per engine for each 1 per cent. of lubricating materials the improvement is capable of saving. In the case of the North Staffordshire Railway, however, where the cost of oil, tallow, &c., is 60*l.* per engine per annum, an expenditure of 4*l.* per engine might be incurred to obtain a saving of 1 per cent.; while on the Great Western, where the annual cost of lubricating material is but 18*l.* per engine, an expenditure of but about 18*s.* per engine would be justifiable to effect a similar economy.

Taking the average results recorded by the Table, we find the various items which go to make up the total of locomotive expenditure to be as follows:

				Per cent.
Salaries, office expenses, and superintendence				2.35
Running expenses:	Wages	... ...	29.7	
	Fuel	... ...	24.1	
	Water	... ...	2.	
	Oil, tallow, &c.	...	5.35	
				61.15
Repairs and renewals:	Wages	... ...	19.4	
	Materials	...	17.1	
				36.5
				100.0

Taken altogether the statistics contained in the Table which we publish this week, entirely confirm the arguments—founded on less complete data—which we have used on previous occasions when writing of locomotive economy. Leaving out of the question such exceptional cases as the Metropolitan, the whole bearing of the evidence available is to the effect that, in the case of a locomotive engine, improvements tending towards economy of fuel are of secondary value as compared with such improvements of construction as will enable a greater annual amount of work to be got out of each engine by reducing the time lost in making repairs; and that in proportion as the work done per engine per annum is increased, so also will be increased the opportunities for the employment of refinements tending to produce economy of fuel.

INDIAN STATE RAILWAYS.

THE delay which has hitherto occurred in the commencement of any of the more important lines of State railways in India, is an evident proof of the difficulty that has been experienced in getting the new machinery to start. The establishments which have already been maintained on some of the proposed lines, in anticipation of an early commencement, must have already cost no small amount, adding thereby to their ultimate cost. What has, in reality, been the hitch, we are unable to say, but there would at last appear to be some grounds for hoping that before the expiration of the year 1872-73 there will be some tangible results for all the reports and correspondence which has necessarily preceded the commencement of any real action in the matter, and some more substantial justification, for the flourish of trumpets, which heralded in the opening of the little Khamgaon branch line, constructed entirely by the Public Works Department. We do not doubt but that there are men, in that Department, as capable as any who have ever been in India to construct the most difficult works, and it is to be hoped that the best men will be permitted to come to the front, and receive credit for what they do. Recently the numerous failures in public buildings, throughout India, has cast somewhat of a slur on the Department, and it is of importance that some conspicuous series of successes should be attained so as to wipe out the memory of past shortcomings. An opportunity now presents itself in connexion with the construction of State railways in India. In vivid recollection of the disastrous floods in the Punjab and in Bengal, and the effects they have produced upon bridges and embankments, we most seriously counsel proper attention to the water-ways provided in bridges and culverts; for, if rumour speaks truly, the late calamities to which we have just referred are due—not to defect in original designs, but to the curtailment of the amount of water-way provided in them, by the consulting engineers to Government, and not by the engineers belonging to the railway companies. But to return to the several railways themselves. The Indore line is now the furthest in advance, and it is to be carried out departmentally; tenders for sleepers of teak and creosoted pine have been advertised for, and the superintending engineer has been making inquiries relative to the proper appliances for workshops, so that it may fairly be assumed that Central India will be pierced before next monsoon. The Rajpootana line, which comes next in order of forwardness, is to be a contract work, and will therefore require most rigid and careful inspection during construction, in order to guard against future misfortunes, such as were recently witnessed

* *Vide* page 125 of the present volume.

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NOTICE OF NEXT MEETING.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, November 14, at 8 p.m. "Pneumatic Despatch Tubes; the Circuit System." By Mr. Carl Siemens, M. Inst. C.E.

THE "ENGINEERING" DIRECTORY is published this week on the thirteenth page of our advertisement sheet.

NOTICE TO AMERICAN SUBSCRIBERS.

In consequence of the great increase in our American connexion, we have found it necessary to establish a branch office in the United States. Communications may in future be addressed to MR. GEORGE EDWARD HARDING, C.E., *of* 176, *Broadway, New York, who is our accredited representative.*

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of* 1*l.* 14*s.* 8*d.* ($8.32, *gold*) *per annum, payable in advance.*

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ENGINEERING.

FRIDAY, NOVEMBER 10, 1871.

LOCOMOTIVE WORKING EXPENDITURE.

IT is but a short time since* we directed attention to the somewhat abnormal position which a locomotive occupies amongst steam engines generally as regards the small opportunities it affords for being worked with a greater economy of fuel. A locomotive with its imperfectly protected and unjacketted cylinders, placed in a position which facilitates the carrying into them by the steam of any water mixed with the latter, cannot be declared a high class type of steam engine; but it is nevertheless a type which has done good service, and it is, moreover, one which it is difficult to modify with any really economical result under the circumstances which govern locomotive working. As we pointed out in our former article, the great obstacle to the improvemant of the locomotive engine as a steam user is the small number of hours per annum during which such an engine is actually working. This small proportion of working time limits the annual monetary saving which any given improvement can effect, and renders the charge for interest on the additional cost of any such improvements disproportionately large. Taking the mean gross cost of an engine as 2400*l.*, and the mean annual cost of fuel as 180*l.* per annum we showed, on the occasion to which we have referred, that even if by doubling the cost of an engine, it was possible to save the whole cost of fuel without incurring any extra charges for depreciation and repairs, the saving would but pay interest at the rate of 7½ per cwt. per annum on the extra outlay. The sum above taken as the annual cost of fuel per engine, namely, 180*l.*, was deduced from an examination of the accounts of ten of the principal English railway companies for the last half year of 1870; but we this week publish on page 310 a Table giving a more complete account of the expenditure on twenty of our principal lines which will enable us to found our deductions on a broader basis.

The Table referred to—which, we believe, will be regarded with much interest by a large section of our readers—contains data derived from the locomotive accounts of the various railways enumerated for the first six months of the present year, and from it we find that the average cost of fuel per engine during that period was 73*l.*, or at the rate of but 142*l.* per engine per annum. Now, if we assume, as we may justly do, that any improvement made in a steam engine should pay, on an average, at least 15 per cent. per annum (5 per cent. for interest on capital, and 10 per cent. for depreciation) on its original extra cost before it can be regarded as being a source of economy, we find that any improvement capable of saving 10 per cent. of the fuel used, must, if applied to a locomotive, cost less than 100*l.*, or that otherwise such an improvement will not prove really an economical one. This deduction agrees with that made in our former article, namely, "that any fuel-saving appliances added to a locomotive must, to avoid their use being attended with a loss, effect on the average a reduction of fuel amounting to 1 per cent. for each 10*l.* of their original cost." This, it must be borne in mind, is an average result, and it is one also applicable to individual lines of great extent and variety of traffic, such as those of the London and North-Western, Great Northern, and similar companies. But although this is the case, a closer investigation of the Table shows us that there are certain lines on which the conditions of working are so exceptional that the above deductions entirely cease to be applicable. This, for instance, is the case with the North London Railway, where the cost of fuel per annum is 264*l.* per engine, or nearly double the average, and still more noticeably so in the case of the Metropolitan Railway, where the annual cost of fuel per engine rises to 528*l.*, a sum more than seven times the average, and more than ten times that incurred per engine per annum on the London and North-Western Railway. The effect of this on the expenditure which it is justifiable to make on fuel-saving improvements is very striking, and, in fact, it will be seen that, whereas, on the average, any improvements which are capable of saving 10 per cent. of fuel should not cost more than 100*l.* per engine, in the case of the Metropolitan Railway such an improvement might be profitably employed even if it increased the cost of each engine by 700*l.* In making this statement we are, of course, supposing that the improvement is of such a character that its maintenance would not involve an annual charge greater than 10 per cent. on its original cost. In the same way we find that on the North London line an additional expenditure of about 190*l.* per engine, would be justifiable for the purpose of obtaining a reduction of 10 per cent. in the consumption of fuel, and a similar statement would apply to the London, Brighton, and South Coast Railway. In the case of the Metropolitan Railway the high cost of fuel per engine per annum is due partly to the high price of the superior kind of coke which it is necessary to employ on that line, partly to the heavy work to be done, and partly to the great mileage obtained from the engines. This mileage, it will be noticed, is more than 80 per cent. in excess of the average, and is nearly 8000 miles per annum greater than it is on any other line in the country. The causes we have above enumerated place the Metropolitan Railway in quite an exceptional position, and afford opportunities for the employment on it of economical expedients which would be inadmissible on other railways.

Turning now to the data given in the Table concerning the expenditure on oil, tallow, &c., we find the average annual cost per engine for these materials to be 32*l.* Applying the same rule as before, namely, that any improvement must effect an annual saving equal to at least 15 per cent. on its original cost, we find the average maximum justifiable expenditure to be about 2*l.* per engine for each 1 per cent. of lubricating materials the improvement is capable of saving. In the case of the North Staffordshire Railway, however, where the cost of oil, tallow, &c., is 60*l.* per engine per annum, an expenditure of 4*l.* per engine might be incurred to obtain a saving of 1 per cent.; while on the Great Western, where the annual cost of lubricating material is but 18*l.* per engine, an expenditure of but about 18*s.* per engine would be justifiable to effect a similar economy.

Taking the average results recorded by the Table, we find the various items which go to make up the total of locomotive expenditure to be as follows:

			Per cent.
Salaries, office expenses, and superintendence			2.35
Running expenses:	Wages	29.7	
	Fuel	24.1	
	Water	2.	
	Oil, tallow, &c. ...	5.35	
			61.15
Repairs and renewals:	Wages	19.4	
	Materials ...	17.1	
			36.5
			100.0

Taken altogether the statistics contained in the Table which we publish this week, entirely confirm the arguments—founded on less complete data—which we have used on previous occasions when writing of locomotive economy. Leaving out of the question such exceptional cases as the Metropolitan, the whole bearing of the evidence available is to the effect that, in the case of a locomotive engine, improvements tending towards economy of fuel are of secondary value as compared with such improvements of construction as will enable a greater annual amount of work to be got out of each engine by reducing the time lost in making repairs; and that in proportion as the work done per engine per annum is increased, so also will be increased the opportunities for the employment of refinements tending to produce economy of fuel.

INDIAN STATE RAILWAYS.

THE delay which has hitherto occurred in the commencement of any of the more important lines of State railways in India, is an evident proof of the difficulty that has been experienced in getting the new machinery to start. The establishments which have already been maintained on some of the proposed lines, in anticipation of an early commencement, must have already cost no small amount, adding thereby to their ultimate cost. What has, in reality, been the hitch, we are unable to say, but there would at last appear to be some grounds for hoping that before the expiration of the year 1872-73 there will be some tangible results for all the reports and correspondence which has necessarily preceded the commencement of any real action in the matter, and some more substantial justification, for the flourish of trumpets, which heralded in the opening of the little Khamgaon branch line, constructed entirely by the Public Works Department. We do not doubt but that there are men, in that Department, as capable as any who have ever been in India to construct the most difficult works, and it is to be hoped that the best men will be permitted to come to the front, and receive credit for what they do. Recently the numerous failures in public buildings, throughout India, has cast somewhat of a slur on the Department, and it is of importance that some conspicuous series of successes should be attained so as to wipe out the memory of past shortcomings. An opportunity now presents itself in connexion with the construction of State railways in India. In vivid recollection of the disastrous floods in the Punjab and in Bengal, and the effects they have produced upon bridges and embankments, we most seriously counsel proper attention to the water-ways provided in bridges and culverts; for, if rumour speaks truly, the late calamities to which we have just referred are due—not to defect in original designs, but to the curtailment of the amount of water-way provided in them, by the consulting engineers to Government, and not by the engineers belonging to the railway companies. But to return to the several railways themselves. The Indore line is now the furthest in advance, and it is to be carried out departmentally; tenders for sleepers of teak and creosoted pine have been advertised for, and the superintending engineer has been making inquiries relative to the proper appliances for workshops, so that it may fairly be assumed that Central India will be pierced before next monsoon. The Rajpootana line, which comes next in order of forwardness, is to be a contract work, and will therefore require most rigid and careful inspection during construction, in order to guard against future misfortunes, such as were recently witnessed

* *Vide* page 125 of the present volume.

on the Great Indian Peninsula Railway. Tenders have been invited, and should before now have been sent in, for a line from Agra to Sambhur Junction station, a distance of 185 miles, with a probable extension to Ajmere and the Salt Lake of Sambhur, which has been leased by Government from the Rajah of Jeypore. It is reported that Government is willing to receive tenders for the work as a whole, or in portions. If a substantial contractor can be found to take up the entire work it will probably be found the cheapest and best, small contractors in India being, as a rule, not much to be depended upon; besides having several petty contracts to attend to, will entail more work upon the superintending engineers, who will thus be less able to devote a proper amount of time to personal inspection of the works as they are in progress. The next in order would have been the line to Hyderabad, from the Great Indian Peninsula Railway a little beyond Gulbarga, but the indecision as to whether this line should be constructed upon the broad gauge, or on the new standard gauge, has occupied much time and caused some delay. It has, however, ultimately been decided that the new narrow gauge shall be adopted, although several miles of earthwork have already been constructed suitable for the former. Captain Pemberton, R.E., has now gone to take overcharge of the works, but revised estimates for the new gauge will have to be prepared before they can be put into full operation. The Northern State Railway, after estimates had all been prepared for continuing the existing gauge from Lahore northwards, has been delayed by a similar change of plan, and the new estimates, it is believed, have already been completed, and the work is now ready for commencement forthwith. It is understood that the question of the location of the Indus Valley line, from Mooltan to Roree, has at last been decided in favour of taking it along the left bank of the Indus. The line from Carwar to Dharwar, intended to facilitate the export of cotton from the latter district, is also stated to be, at last, fairly in hand. This work will open up the Southern Mahratta country, and it is intended ultimately to extend it to Bangalore on the south-east, and towards the Nizam's dominions, by Bellary, on the north-east. After much difficult survey work, a route from the coast up to Hoohlee, and the fertile table land of Dharwar, has been all but finally settled; the plans and estimates are now being gone through, and there is some faint hope that the line may be commenced from the point of Carwar next cold season. These two last-named lines will present some difficulties in construction; the former, on account of the number of streams that will have to be crossed, and the amount of embankment that will be required, passing, as it must, in a portion at least of its length, within the flood line of the river Indus. On the latter some heavy cuttings and earthworks will be required, as the line climbs up the western ghauts, which must be surmounted before the table land can be reached. There are besides other lines in contemplation, but no progress appears as yet to have been made towards their commencement. Amongst these, perhaps, the most important one is that projected to connect the coalfields of Chanda with the Great Indian Peninsula line. As the railways in India become extended, the question of fuel will undoubtedly become one of vast importance, and no time should therefore be lost in fully developing the coal resources which India possesses, as any delay in this respect is calculated to lead hereafter to serious consequences. Until the newly-discovered coal-beds have been got into full working order, it is impossible that they will be able to supply a sufficiency of fuel at a cheap rate, and there can be no encouragement to mine coal if there is not at hand a ready market for the sale of it. This is a question which demands immediate attention, and for the cause of future economy, every inducement should be held out for extensive working, and every effort made to bring the market for their produce into the closest possible proximity to the works.

THE OXYHYDRIC LIGHT.

During the past week there has been exhibited at the Crystal Palace a light which, although new to this country, has already been tested in France and in America with results which render it entitled to special attention. The light to which we allude is the "oxyhydric" light of M. Tessie du Motay—of whose process of manufacturing oxygen we have on several occasions spoken in this journal—and it is produced by consuming ordinary coal gas with a supply of pure oxygen. The burners generally used by M. Tessie du Motay have a cup-shaped recess formed in the top, a central hole at the bottom of this recess furnishing the supply of oxygen, while the ordinary coal gas escapes through a number of small openings which surround the central one, and which are directed inwards. The result of this arrangement is a flame of a steady conical form, affording a pure white light of remarkable brilliancy. M. Tessie de Motay also, in some instances, uses other forms of burners for giving a flat flame, but the form we have described is that he most generally employs. The oxygen and coal gas are conveyed to each burner through separate pipes, the supply of each being regulated by independent cocks. The quantity of oxygen used is about $\frac{1}{2}$ of a cubic foot for each cubic foot of coal gas, and it is affirmed by the inventor that each cubic foot of coal gas, burnt with $\frac{1}{2}$ cubic foot of oxygen in the manner we have described, will give an amount of light equal to that obtained by the combustion of 5 cubic feet of gas in the ordinary way. This, however, is a point upon which we must speak with a certain amount of reserve, as we are not in possession of any precise data bearing upon the subject. Whatever may be the exact proportion between the light given out by gas burnt on M. Tessie du Motay's plan, and that consumed in the ordinary way, there can be no doubt that the former system affords a light vastly superior to the latter, in fact, so superior that when the new and the ordinary lights were shown burning side by side at the Crystal Palace, the ordinary gas flames appeared to resemble the flame of a second-rate candle, when brought into a brilliantly gas-lit room.

Of course the whole question of the success or non-success of the new light depends upon the possibility of furnishing a supply of oxygen gas on a large scale at a sufficiently moderate rate; and it is in fact M. Tessie du Motay's method of manufacturing oxygen which constitutes the soul of his invention. This process we have already described in this journal, but it may be as well that we should repeat some particulars of it here. M. Tessie du Motay, then, obtains his supply of oxygen from the atmosphere by taking advantage of the fact that permanganate of soda gives up a portion of its oxygen when subjected to the action of superheated steam, and that it re-absorbs a supply of that gas when subsequently traversed by a stream of hot air. In practice the manufacture is carried out as follows: The permanganate of soda, mixed with a certain proportion of oxides of copper and manganese, to prevent the mass from fusing together, is placed upon gratings in cast-iron retorts, which are set in a similar way to ordinary gas retorts, and heated to a dull red heat. To separate the oxygen, the contents of the retorts are subjected to a current of superheated steam, and the combined steam and oxygen are led off to a condenser, where the steam is separated by condensation, and whence the oxygen gas is drawn off to suitable gas-holders. The permanganate, after being exposed to the action of steam for a few minutes, is next traversed by a current of heated air, which is forced through the retorts by suitable air pumps. This air effects the re-oxidation of the permanganate, the nitrogen passing off through a waste pipe. The permanganate after being re-oxidised is again subjected to the action of the steam, and so on for an indefinite period, the efficiency of the permanganate not appearing to be affected by the successive de-oxidation and re-oxidation. Of course, in practice the retorts are divided into two sets of groups, one of which is subjected to the action of the steam, whilst the other is being traversed by a stream of air, and *vice versâ*, so that a constant supply of oxygen is furnished. After being traversed by the current of steam the permanganate is converted into a mixture of oxide of manganese and hydrated soda, and to prevent this soda from being converted into a carbonate, it is necessary to remove the carbonic acid from the air before it is allowed to traverse the retorts. This is done by causing it to traverse lime water, or a solution of caustic soda or potash. At the Crystal Palace, however, where operations are only carried on on an experimental scale—but two retorts being in use—and where it is not intended to continue the manufacture for a lengthened period, this preliminary washing of the air is dispensed with. Each 100 lb. of the permanganate yields about 175 cubic feet of oxygen each time it is treated with the superheated steam.

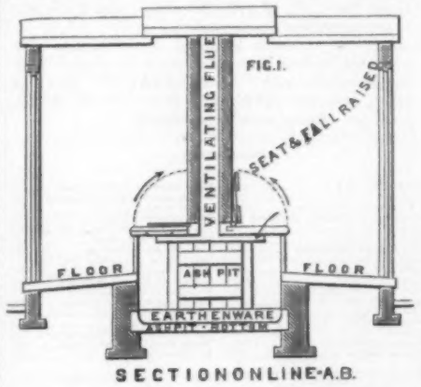
As regards the cost of producing the oxygen, we cannot speak definitely, as it will depend in a great measure upon the demand for it and the facility for delivery. It is stated, however, that the actual cost of manufacture is not more than about 3s. per 1000 cubic feet, and that, even if delivered to houses in gasometers, its cost would not be more than 15s. per 1000 cubic feet. At this rate, and if used in combination with extra carburetted coal gas, costing about 1s. per 1000 cubic feet more than that ordinarily supplied, the cost of the oxyhydric light is estimated at about 20 per cent. less than that of the ordinary gas light of equal power, but much inferior purity. These, however, are but approximate estimates, and we must leave this portion of the subject for future comment, when we have more data at command.

We have now given a brief account of M. Tessie du Motay's plans, and we hope shortly to be able to illustrate the whole of the arrangements employed, and give more detailed particulars of what promises to be a very valuable system of illumination. We may add, in conclusion, that an important feature in the new light is its remarkably small heating power, and the facilities it affords for entirely preventing the damage but too frequently done by the imperfect combustion of ordinary gas.

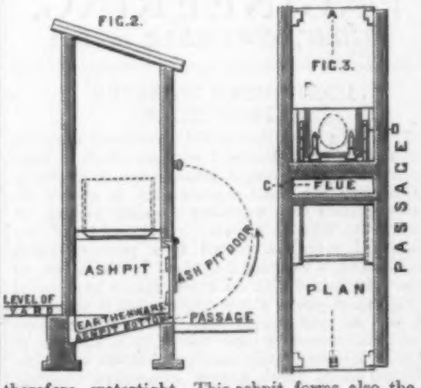
THE SEWAGE AT BIRMINGHAM.

(*Continued from page* 274.)

We give on the present page illustrations of the improved modes of dealing with excreta and ashes introduced at Manchester and Rochdale. The improved privies at Manchester (See Figs. 1, 2, and 3) are built without any midden. The bottom of the ashpit is of glazed earthenware, and,

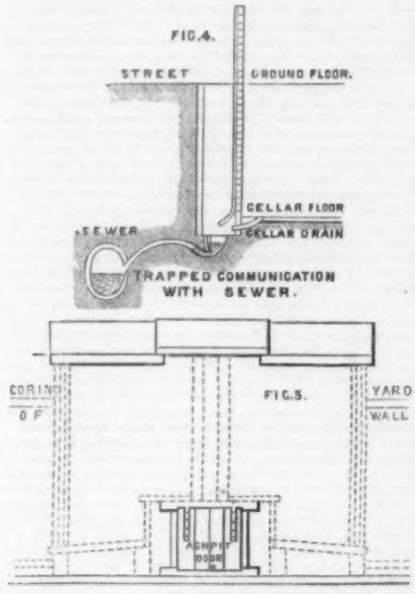


SECTION ON LINE A.B.



therefore, watertight. This ashpit forms also the receptacle for all the excreta. It will be observed that both seat and fall can be raised, for the purpose of throwing in ashes without soiling the seat. By the construction of privy here shown a very important advantage is gained, inasmuch as the excreta and ashes are alternately deposited, so that a considerable deodorising action is brought to bear. By reason of this deodorising action, and the provision of the ventilating flue—which is always carried up 3 ft. above the eaves of the adjoining dwelling—offensive odours are effectually guarded against. The glazed earthenware pan forming the bottom of the ashpit prevents any leakage of excrementitious matter into the sur-

rounding soil. By a provision of the regulations in force, it is requisite, when pulling down the old privies and middens to erect new privies on the system illustrated, to have all the excrement sodden soil excavated to a depth of 18 in., and carted away from the premises; the resulting pit being then rammed full of dry, clear material. The work has all to be done to the satisfaction of the city surveyor, and certified by him in writing before being deemed complete. The very simple plan of trapping the communications with the sewers, shown by Fig. 4, is being extensively carried out, to the very great improvement of the city. Fig. 5 shows an elevation of closets in a passage.



The system introduced at Rochdale is distinctly different to the Manchester plan, though both alike aim at the complete exclusion of excreta and excremental drainage from the sewers. In Rochdale the ashes are carefully kept separate from the excreta in the following way. The privies are constructed as shown in Fig. 6. In place of

Fig. 6.

the glazed earthenware ashpit of the Manchester privy, a galvanised iron receptacle is provided for the excreta, and a wooden tub for the ashes. The average cost of these privies is about 2*l.*; to which must be added 10s. for the galvanised iron pan. The pans of excreta are collected by means of the covered van shown in the annexed Fig. 7; and the ashtubs are emptied into an ordinary dust cart. The Corporation of Rochdale have some manure works where the excreta are manufactured into a portable manure, which commands a ready sale at 15s. per ton. At present the cost of manufacture, including interest on capital and all other items is 14s. per ton, but this will shortly be reduced, probably to about 12s.

After a personal examination of the working of the Manchester and Rochdale systems, the Birmingham Committee report in favour of giving both an extensive trial; though stating their firm opinion that the Rochdale plan is the better of the two. There can be no doubt that, for manurial purposes, it is better to keep the ashes and excreta separate until after collection from the dwellings. A short description of the mode of treatment adopted at Rochdale will prove this.

In each of the galvanised iron pans placed beneath the privy seats, is put a small quantity of a

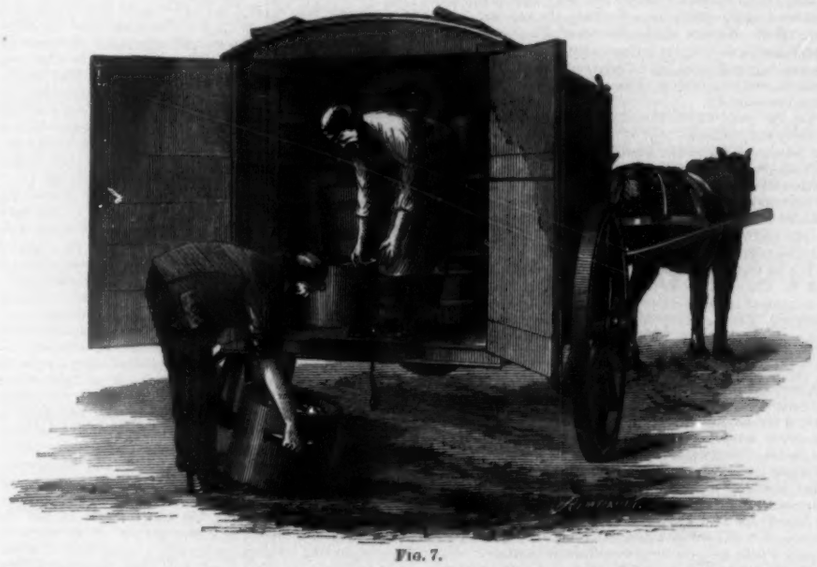


Fig. 7.

disinfecting fluid. These vessels are removed in the daytime to the manure works by means of the covered van. Thus the abominable nuisance, so common in all midden towns, of heaps of putrescent filth being wheeled into the roadways at night, is completely avoided. The removals in Rochdale take place weekly, or oftener if necessary. The cinders, ashes, and other rubbish collected by the dust carts, are taken to the same works as the excreta. The rubbish is all screened, and the large cinders are sold at the rate of 3s. per ton, at which price a ready sale is found. The smaller cinders are found available for raising all the steam power required for driving the machinery used in the various processes. All the vegetable matter found in the rubbish is burnt; and its ash is then mixed with the fine coal ash which has been screened from the cinders. The whole of the fine ashes thus obtained are thoroughly incorporated with the excreta; the mixture being afterwards chemically treated, and laid in heaps for about three weeks. "It is then a damp powdery manure, containing all the constituents of the fæces and urine except a large portion of the water."

The urine from the public urinals, and the blood from the slaughter-houses are also used in the manufacture of the manure.

The Birmingham Committee say that the privies on this system, inspected by them, "were found to be perfectly clean and inodorous."

Even supposing that all the excreta of a town were excluded from the sewers, and the refuse of the slaughter-houses separately collected, the sewage water, especially in dry weather, would still be far too offensive to admit of its being run into small inland rivers, which have no great volume of water, and have far to traverse before reaching the sea. It is, therefore, necessary under any circumstances to adopt some mode of purifying the sewage of all inland towns. The difficult point to decide is, what system of purification to adopt.

The several methods hitherto proposed, and partially used, are:

1. Precipitation by chemical means.
2. Filtration by mechanical means only, or by a combination of mechanical with chemical means.
3. Irrigation.

The last method of dealing with sewage practically divides itself into two widely different modes of procedure. One is to use a small area of land as a natural filter for purifying the sewage water before allowing it to drain into the streams which carry off the surplus water of the district. In this case the growth of any crops fit for use becomes a matter of uncertainty. The other branch of irrigation consists in the use of the sewage as a manure for producing crops at a commercially profitable rate. The first process the committee call purification; the second utilisation; and for want of better terms, we propose to follow their nomenclature. We have, therefore, to consider (1) precipitation; (2) filtration; and (3) irrigation, divided into the minor heads (*a*) purification and (*b*) utilisation. On all these points the Birmingham Inquiry Committee have collected the most ample, recent, and trustworthy information. In fact it is but just to say that their report places the sewage question far in advance of what it was before the completion of the committee's inquiry. Taking first in order the evidence collected by the committee on the comparative efficiency of the various processes of precipitation, we do not find any very encouraging prospect of being able to deal with the sewage of a town like Birmingham by means of any mode of precipitation yet discovered.

The first process examined is that known as the *Lime Process*, which simply consists in mixing about one ton of milk of lime with each million tons of sewage; then agitating the mixture by a stirring machine; and finally running it into settling tanks. The sewage water is run off in a clear state, but highly charged with putrescible matter in solution, and totally unfit to be turned into any running stream. The slush left in the settling tanks is a horribly offensive compound, and the process of drying it takes a long time, and causes a nuisance. Inasmuch as the clarified water carries off the most valuable constituents of the sewage, the residual manure is almost unsaleable. This process has been employed at Tottenham, Blackburn, and Leicester.

At Northampton a modification of the lime process has been applied, but without any really satisfactory result. In this case twelve bushels of lime and six gallons of a solution of chloride of iron are mixed with each million gallons of sewage. The sewage thus treated is afterwards filtered upwards through about 8 in. of calcined iron ore. The Rivers' Pollution Commissioners express a decided opinion that this filtration effects no more than could be done at less cost by mere subsidence. The most noticeable point about this process as exhibited at Northampton is this. The sewage after treatment flows through a culvert about 1½ miles in length, and then enters the Nen "in a nearly clear and apparently innocuous condition." Analysis, however, shows that it contains a very large amount of putrescible matter. In truth the putrescence of the sewage is merely delayed by the action of the chloride of iron. "Indeed, the river Nen does eventually become putrid in consequence of

this discharge into it, and an injunction was granted by the Court of Chancery to restrain the Improvement Commissioners from discharging the sewage of the town into it after the 1st of June, 1870." It is stated that this process removes almost the whole of the suspended matters, rather more than one-half of the organic nitrogen, and about one-sixth of the ammonia. It is evident, therefore, that the most valuable constituents, and those calculated to produce a nuisance escape. The Northampton Corporation are now preparing to use their sewage for irrigation.

(To be continued.)

THE LATE MR. JAMES EASTON.

Mr. James Easton, to whose death we alluded last week, was born at Bradford, near Taunton, the last day of the year 1796. He was the fourth son of Mr. Josiah Easton, a well-known land agent and surveyor, and to the year 1822 he was engaged with his father in surveying for land enclosures, and in a variety of local engineering works, estate improvements, &c.

In the year 1822 Mr. Easton introduced into this country the hydraulic ram or "Bélier hydraulique," having purchased the patent from the celebrated Montgolfier. The machine, as then constructed, would not, however, work with precision, and it was only after a long course of experiments, and some failures, that Mr. Easton was enabled to render it thoroughly efficient and certain in its action, and no material improvement has been made in the machine since.

For its better introduction, Mr. Easton established himself in London as a civil engineer, and in the year 1825 was engaged in the projected survey of the London Northern Railroad, Messrs. Chapman and Jessop being engineers for the northern section, and Mr. George Rennie for the southern.

In order to obtain correct information as to the working of the different rail and tram roads then in existence, Mr. Easton, in the early part of 1825, visited all the principal collieries, and made experiments on the tractive force required for moving loads on railways, and published the results in a tabular form. At the same time several other engineers, afterwards famous in their profession—Sir William Cubitt, James Walker, Rastrick, and Sylvester—were similarly engaged, and they frequently met to compare notes. It is remarkable that to none of them ever occurred the idea that the railroads would be used for passenger traffic, or do more than compete with canals and common road wagons for the carriage of goods.

The locomotive engine and rolling stock generally was then so far from its present state of efficiency that the conclusion was arrived at unanimously that, to quote the words of Mr. Easton's note-book, "These experiments clearly show that it is more economical to make a railroad as much as possible on the level, and to elevate by inclined planes, in case the trade is enough to keep a stationary engine constantly at work."

On these principles Mr. Easton surveyed the line from London to Peterborough, and executed the parliamentary plans for that section in conjunction with Mr. Rennie. Application was made to Parliament for an Act in 1826, but the monetary crisis of that year caused the directors, who were some of the most influential men of the day, to abandon the Bill.

Mr. Easton then turned his attention to the mechanical branch of his profession, and in 1827 entered into partnership with Mr. Leaky, of the Grove, Southwark.

In 1829 the partnership was dissolved, and Mr. Easton, having extended his premises to put up a larger engine, conceived the idea of letting steam power to trades requiring small power, and for more than 20 years had for his tenants, glass-cutters, spectacle lens makers, isinglass manufacturers, &c. In 1835 he designed and carried out works for the supply of Ramsgate with water. Having noticed that at low tide numerous streams of perfectly fresh water ran into the sea through the sand and beach, he considered that by sinking wells inland in the chalk, and driving tunnels at about the level of low-water mark, these would be intercepted, and an ample supply obtained. This plan proved perfectly successful, and has since been generally adopted in obtaining water from the chalk near the sea coast.

In 1834-35 Mr. Easton was consulted as to the improvement of the navigation of Crayford Creek, and was appointed engineer to the commissioners, which post he retained for upwards of 30 years. Under his directions both Dartford and Crayford Creeks were deepened and altered so as to admit of vessels of very considerable tonnage getting up as far as the tide flowed. He also had under his charge the whole of the drainage district from Woolwich to Dartford, and carried out works by which the level and the soakage water was so much lowered that not only was the land converted from swampy pasture into first-rate arable land, but ague, which had for years been a scourge to the neighbourhood, became almost unknown.

In 1837 Mr. Easton took into partnership Mr. C. E. Amos, the business being thenceforward, for nearly 30 years, carried on under the title of Easton and Amos.

Three years later he was consulted by Her Majesty's Commissioners of Woods and Forests as to providing the water for the supply of the fountains recommended in Mr. Charles Barry's design for Trafalgar-square, and having already successfully sunk artesian wells into the chalk, he advised the adoption of that mode of supply, and submitted a plan for carrying it out.

Two wells were sunk under his directions to a depth of 200 ft. into the London clay—one in Orange-street and one in front of the National Gallery, and connected together by a tunnel driven at that depth through the clay. Borings were made into the chalk, and the result was so successful that not only the fountains, but also all the public offices in Westminster, the Barracks, and ultimately the Houses of Parliament were supplied from these works. The water was also served to St. James's and Buckingham Palaces, Sir James Clark having specially recommended it on account of its salubrious qualities for the use of Her Majesty.

In 1848, at the request of the Commissioners of Woods and Forests, Mr. Easton reported on the question of cleansing the Serpentine. He proposed to level the bottom, and, having first covered the softer parts with brushwood or long straw, to spread a layer of concrete over the entire surface, thus saving the cost and annoyance of removing the mud, in the manner recently adopted. His plan was not acted upon at the time, but in 1857 the lake in St. James's Park was most successfully treated according to his suggestions, and an abundant supply of water obtained for it by sinking a large trench into the Thames ballast that underlies the peat and clay of Westminster, laying unjointed earthenware pipes, covered with brushwood before being filled in, and conducting them to a well on Duck Island, from which the water was raised by a pumping engine. Later on, when the filtering scheme at the head of the Serpentine (with which he was in no way connected) was abandoned, he utilised the engines there to obtain a further supply of water, and carried out a network of pipes which afford an inexhaustible supply of water for the parks, roads, and plantations, and for almost any number of steam fire engines round the palaces and public buildings.

Among his smaller works were the arrangements for the supply of water to the house and grounds at Osborne; the water works at the Horticultural Gardens, where he sunk an artesian well with success as great as that which attended the similar works in Trafalgar-square; the supply of Torquay, where the water is brought from Dartmoor in pipes, which for several miles are under a pressure of some 330 lb. per square inch; the Brighton Water Works, drawing their supply from wells in the chalk, and distributing it in zones at different levels. The works here enumerated are those in which Mr. Easton was himself more immediately concerned, but during his whole career he had the control and supervision as senior partner of an extensive manufacturing business, demanding a great deal of attention to details of management and great financial ability. His firm, as is well known, was largely engaged in the erection of paper and corn mills, hydraulic machinery of various kinds, especially centrifugal drainage engines, and other works too numerous to mention. In 1839 they erected the first continuous hydraulic lead pipemaking machine in London, and in 1864 established their branch works on the banks of the Thames at Erith. In 1866 Mr. Easton and Mr. Amos both retired from business, but the former still continued to take an active interest in many of the works he had originated or carried out, and remained engineer to the Government water works already described till the day of his death.

In 1827 Mr. Easton married the only child of the late Mr. Benjamin Shaw, a gentleman well known in the City, and twice in succession Prime Warden of the Fishmongers' Company.

Mr. Easton's character deserves a moment's notice for its extreme simplicity and straightforwardness of purpose. Acute in discriminating between right and wrong, he used resolutely to adopt the course he considered the honest one, and would carry out his views in the simplest and most direct manner.

The Emma Silver Mine, Utah.—We notice the proposed formation of a company with a capital of 1,000,000*l.* sterling, to purchase the property known as the Emma Silver Mine, at Utah. The Emma mine has already achieved a marvellous celebrity from the richness of its ores, and their great extent, and the report of Professor B. Silliman, the well-known professor of general and applied chemistry of Yale College, ranks it as one of the great mines of the world. It is only a little more than twelve months since the mineral wealth of Utah was developed, and already the proceeds of some of the workings have exceeded the most sanguine expectations of the owners. The mine now brought before the public is valued at 1,000,000*l.* so that the whole of the capital will be handed to the vendors, half in cash, for which applications are now made to the public, and half in fully paid-up shares. On the other hand the purchasers of the property will receive ore now *en route* for England to the value of 181,500*l.*, equivalent to a dividend of 18 per cent. for one year, besides the mine and claims connected with it, and the machinery and plant upon the works. The sale of the ore already raised and forwarded, and the smelting of that now piled up at the mine, will also provide working capital. The directors propose to limit the dividends to 18 per cent. per annum, accumulating a reserve fund, until it amounts to a year's dividend at that rate, after which the whole of the proceeds will be divided amongst the shareholders, with such reservations as the directors think advisable. A special feature mentioned in the prospectus is that of paying dividends monthly, and the directors anticipate extremely favourable results from the fact that the reports show that returns will be immediate, and very large, even upon the great amount of capital.

THE PORT OF HARTLEPOOL.

At a recent meeting of the Hartlepool port and harbour commissioners, a somewhat interesting report was read by Mr. J. Hawkins, the engineer, which contains a description of the exact condition of the harbour and works connected with it. The following is an abstract of the report.

Dredging of Entrances.—Upwards of 21,000 tons have been dredged from the entrance to the old harbour, and deposited at sea by the hoppers during the past month, making a total quantity since the commencement of the season of 172,660 tons. The usual monthly soundings were taken on the 25th October; they show a further improvement in the depth of water in the channel leading to the old harbour to seawards of the harbour entrance, and a slight diminution of the depth within the harbour itself. I have taken this opportunity of bringing before your notice a comparison between the depths now obtained and those existing at the same period of last year, and of the year previous, and also to offer a few remarks founded on my own observations. I have found by referring to the charts exhibiting the soundings taken at these dates that in October, 1869, there was not a single sounding, within the area now occupied by the channel and extending about 500 yards to seawards of the end of the old pier, showing a depth of 7 ft. at low water of spring tides, and very few showing even 6 ft. of water, excepting in the outer line where the channel reaches the general contour line of that depth in the bay. In October, 1870, there was an area of 6¼ acres, all of which covered a depth of not less than 7 ft. at low water of spring tides, and according to the soundings taken during the present October there is now an area of 16 acres covering depths of 7 ft. and upwards. In November the area enclosing depths of 7 ft. and upwards was nine acres, and in March last it was reduced to rather less than six acres, so that it is evident that the channel had been affected by shoaling during the winter months to such an extent as to lose one-third of its deep water area. Part of this loss was, I think, due to storms, but I do not think that the deposits thus formed are to be regarded with so much alarm as the slow growing spits of sand which keep on increasing and encroaching, because they are fed from an abundant source, and the motion which supplies them is constant and well sustained, though not very powerful. The reason I have for supposing that part of the deposit in March resulted from such a cause is that the soundings taken in June following showed that the channel had been more than restored to its former dimensions, and it was improbable that this had been entirely effected by the dredging which had taken place up to that time. The shoal had been permanent enough to remain over May, but was removed by another natural effort of the currents previous to June. I think I have now stated enough to justify the confident opinion I entertain, that a deep-water channel to the old harbour may not only be excavated but may also be maintained without much difficulty. Constant dredging in favourable weather will no doubt be required, and as the winter season cannot be made use of at present, two or three months in every year will have to be devoted to the work of repairing the effects of the encroachments likely to take place in the winter. But as the breakwater works are extended, I anticipate that the dredging operations will be carried on much longer than at present, and with more security to the plant, owing to the additional protection which will doubtless be afforded to this part of the bay; and I have no hesitation in stating that, with the appliances at present in use, and with moderate success and average weather a channel 10 ft. deep and sufficiently wide for safe and easy navigation may, if necessary, be got by the latter end of next year.

Extension of Breakwater—The progress of this work during the month has been upon the whole satisfactory. A length of 27 ft. is now completed with the exception of the parapet. The bell work and the laying of the foundation course has also progressed fairly, and although I do not expect a very great advancement of the length of the work during the winter months, much may be done in the way of preparations for future operations, and advantage will be taken of every favourable opportunity to excavate the rock for the reception of the foundation course. When the sea is too rough for bell work, block making will go on, so that the beginning of next spring will in all probability find the contractors well supplied with material for building the breakwater, and, should the staging stand intact throughout the winter, with plant and appliances for rapidly executing the work.

Old Harbour Works.—It has been necessary to carry out during the month some minor repairs, both to the foundation of the Town Wall and to the end of the old jetty, the latter work being particularly rotten.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Market.—Yesterday there was considerable animation on 'Change at Middlesbrough. Pig iron of every description was in great demand. Merchants anxious to ship as much iron as possible before the close of the navigation season paid 55s. per ton for No. 3. Higher prices were asked by some makers, the simple fact being that iron could not be had. Every smelter has orders which will keep him occupied far into next year, and good prices are being obtained for delivery over the next six months. The genuine condition of the trade of Cleveland is shown by the statistics just published concerning the make during October. Of the 132 blast furnaces in the North of England, no fewer than 124 are in full blast.

The New Blast Furnaces—There are nine new blast furnaces in course of construction in the north of England. As might be expected, the most of these are being built in the Middlesbrough district, which is certainly the greatest iron-producing place in the world. The Lackenby Iron Co., Middlesbrough, are building one; Cochrane and Co.,

Middlesbrough, are building one; Gjers, Mills, and Co., Middlesbrough, are building two; B. Samuelson and Co., Middlesbrough, are building one; the Consett Iron Company, Consett, are building one; the North of England Industrial Iron Company, Stockton, are building one, and the Rosedale and Ferryhill Iron Company are building two.

The Finished Iron Trade.—Every branch of the finished iron trade is in a satisfactory condition and the prospects for next year are most assuring. Rail inquiries are numerous, and considering the requirements of Germany, Austria, Russia, America, and India, it is generally calculated that the North of England will have as good a year in 1872 as it has had for a long time past. In consequence of the great activity in the iron shipbuilding trade throughout the kingdom there is an immense demand for plates and angle iron, bars, bolts, nuts, and rods.

The Nine Hours' Movement at Middlesbrough.—Last week we called attention to a meeting of engineers which had been held at Middlesbrough at which it was resolved to accept the nine hours' system only on condition that the Sunderland terms were granted. On Saturday last the whole of the fitters, smiths, boiler makers, moulders, pattern makers, and labourers connected therewith, employed at Messrs. Bolckow, Vaughan, and Company's works, Middlesbrough, gave notice that unless the nine hours' system was granted on terms with overtime unaltered, viz., that each day should stand by itself, they would cease to work after the expiration of 14 days. The employers have taken no action in the matter. To-morrow (Thursday) evening a mass meeting of the men is to be held at Middlesbrough. We hope that the question will not be neglected, for there is always a fear of meetings stirring up a feeling to strike if demands are not speedily acceded to. It would be far better if the masters, instead of allowing time for the holding of public meetings, called their men together and quietly discussed the question and arranged matters in an amicable way.

NOTES FROM THE SOUTH-WEST.

Railway Iron for Austria.—The Craigforth screw steamer has cleared from Cardiff for Trieste with 1020 tons of railway iron supplied by the Rhymney Iron Company.

Progress of Maesteg.—The iron works at Maesteg are in a prosperous state. A new mill, containing 21 puddling furnaces and 12 balling furnaces, will be in working order in a few days. Important additions are being made to the Llwydarth tin works. It is also rumoured that a cotton factory will be shortly established by some Manchester capitalists.

New Line to Thornbury.—The branch line from Yate to Thornbury is now nearly completed. It is expected to be opened for traffic early next year.

Strike in the Forest of Dean.—A miners' strike in the Forest of Dean, which lasted some time, has been happily brought to a conclusion. The masters concede an advance of wages, but they refuse to abolish what is known as the five weeks' pay system.

Trade at Newport.—Trade is tolerably brisk at Newport. The demand for Newport steam coal has been increasing. The iron trade has been comparatively quiet; there have, however, been considerable shipments to the United States; large shipments of rails have also been made to the west coast of South America. Some vessels have arrived with iron ore from Spain.

Great Western Railway.—The Great Western Railway Company, in making their line from Newport to Pontypool, will erect a bridge over the Usk below the Duckpool farm. The bridge will consist of five spans of 80 ft. each. It will be 12 ft. above high water at spring tides.

South Midland Railway.—A meeting to consider a scheme by which it is proposed to connect the Welsh and Forest coal-fields with Southampton, was held at Gloucester on Saturday. The chairman said the Severn must be bridged, but it was not probable that more than one bridge would be sanctioned or built; it behoved Gloucester men, then, to exert themselves to secure the erection of the bridge on the best site, which appeared to be near Sharpness. Mr. Pain, one of the engineers concerned, described the proposed line, and stated that Lord Fitzhardinge had announced his intention to oppose any bridge scheme. A resolution was unanimously adopted to the effect that the South Midland Railway would establish the best and most direct route from South Wales, the Forest of Dean, the Berkeley Docks, the Gloucester Docks, and Nailsworth to Wootton Bassett, and Basingstoke for London, and to Andover for Southampton.

Devon and Somerset Railway.—This line is expected to be completed in about seven months.

Sewage at Taunton.—The Taunton Local Board of Health has been again occupied with the question of the disposal of the sewage of the town. Mr. Sutton, of the Exeter Sewage Company, who recently offered to purchase land, erect, and carry on works for the disposal of the sewage, handing the affair over to the Board at the expiration of thirty years, has now sought a provisional agreement for three months to enable him to form a company with a capital of 8000*l.* The terms applied for are that the Board should grant him a lease of the works for 25 years, he paying the nominal rent of 5*l.* per annum and 7 per cent. per annum for the outlay, and undertaking to hand the whole premises over to the Board on the expiration of the lease, the Board for the present to pay the expense of bringing all the sewage to one point.

Wages at Pontypridd.—The men in the employment of Mr. Rowlands, proprietor of the Newbridge and Gellywion colliery, threatened to strike on the 1st inst. They have had, however, an advance of 5 per cent. granted to them, and they accordingly remain at work.

Trade at Merthyr Tydfil.—The iron trade in the Merthyr Tydfil district remains in a fairly prosperous condition. Large quantities of rails are being made for the Southern States of America. There is also some demand for bar iron on Italian account.

FOREIGN AND COLONIAL NOTES.

Kaipara (N.Z.) Railway.—A commencement has been made with the works on the Kaipara (New Zealand) Railway at Hawkins's Point. The railway is to connect the waters of the Waitemata (Auckland) with those of the noble Kaipara harbour on the west coast of the north island. The line will be about 16 miles in length, and the contract has been taken by Mr. Edgar for 43,000*l.* The line is expected to be finished off in 18 months; it will open up a large extent of fine agricultural country. The cost of the line is to be borne by the Province of Auckland, alone, no portion of the outlay being sustained by the general Treasury of New Zealand.

The Belgian Iron Trade.—This trade is favourably spoken of. The demand for rails, which has been languid for some time past, has experienced an improvement.

Another Great Bridge over the Missouri.—Mr. L. B. Boomer, of Chicago, has obtained a contract for building a bridge across the Missouri, at Atcheson, Kansas. The bridge is to be completed within twelve months for 850,000 dollars, that sum including the approaches.

Victorian Locomotives.—The tender of a Ballarat firm for the construction of ten locomotives has been accepted by the Victorian Government. The price of the engines, exclusive of wheels and axles, is to be 2900*l.* each. This may seem a stiff figure, and so no doubt it is. It must be remembered, however, that it costs a good deal to transport an English-built locomotive to Melbourne and reconstruct it on its arrival.

The Suez Canal.—With the help of the loan which it has partially negotiated, the Suez Canal Company hopes to be enabled to pay in the first quarter of next year the coupons which became due upon its obligations in April, 1871. The company also hopes to be able to provide in the course of next year for the coupons of October, 1871, the coupons of April, 1872, and the coupons of October, 1872. In the course of September, the company sold plant to the value of 10,004*l.*, it is this item which caused the receipts of the month to be exceptionally heavy. The ordinary revenue from the transit of ships through the canal increased, however, in September to the extent of 8207*l.*, as compared with September, 1870.

The Narrow Gauge in the United States.—Two narrow gauge locomotives have been shipped from Pittsburg for the Cherokee Railway Company of Georgia. They were the first narrow gauge locomotives built west of the Alleghany mountains.

Lake Shore and Michigan Southern Railway.—This company has built at Elkhart, Indiana, a machine shop of brick and iron 600 ft. in length by 120 ft. in width, with a blacksmiths' shop connected therewith 100 ft. in length by 72 ft. in width. The cost of these shops, together with some other improvements, was 141,881 dols. The machine shop at Adrian has been appropriated to the car department, and the shop at Laporte has been entirely discontinued. These measures are expected to secure rather important economies.

Proposed Canadian Steam Line.—Mr. Cramp, of Montreal, has been in England during the last few days. The object of his mission is to arrange preliminaries in regard to a proposed new steam ship service to the St. Lawrence.

The Australian Overland Telegraph.—Intelligence as to the progress of the great Australian overland telegraph is now brought down to August 23. The information to hand is satisfactory. Rapid progress was being made with all the sections, and the cartage contracts were well forward. Rain was, however, a good deal wanted.

Indian Railways.—The tender of a Poona firm for the construction of the Goolburga and Hyderabad (the Nizanis) line is said to have been accepted. In that case, the work will be well in hand before the close of the year. The surveys for the Mysore Railway have been completed; and in regard to the Carwar and Dharwar districts line, everything is nearly ready for the final orders from Simla.

Coal at Boston.—The receipts of coal at Boston, U.S., to October 10 this year were as follows:—Anthracite, 451,059 tons; Cumberland, 183,442 tons; and foreign, 81,042 tons. In the corresponding period of 1870, the totals stood thus:—Anthracite, 448,711 tons; Cumberland, 160,016 tons; and foreign, 89,984 tons.

Steam Shipping at Quebec.—It is stated at Quebec that Sir Hugh Allan intends to make Quebec the head-quarters of the Allan line. It is also stated that the Allan steamers will not proceed further than Quebec.

Adelaide and Glenelg Railway.—It is proposed to construct a line between Adelaide, the capital of South Australia and Glenelg. A bill to authorise the construction of the line has been brought into the South Australian legislature.

Montreal and Ottawa Junction Railway.—It is proposed to construct a line under this title. The total distance will be only 80 miles, and according to the working plans the outlay will not exceed 13,000 dols. per mile for a 4 ft. 8½ in. road. Mr. Legge, C.E., of Montreal, has prepared the plans.

Steam Shipping at New York.—The capital invested in the steamers plying between New York and foreign parts is estimated at upwards of 28,000,000 dols., calculating the average burthen of each vessel at 2500 tons. This is probably a low calculation, rather than otherwise.

Telegraphy in the East.—The Telegraph Construction and Maintenance Company has now completed the laying of all its submarine cables between Marmaritza, Rhodes, Candia, Rethymo, and Canea; between Cyprus and Latakia, Samos and Scala, Nuovo, Scio, and Tchesme; and between Mytalene and Aivali. The public will thus be enabled to transmit messages by these cables throughout the Archipelago.

Turkish Armaments.—Halil Pasha, Grand Master of Artillery in Turkey, has formed a school of young Turkish officers and workmen at Tophanch, who are thoroughly trained in all relating to armaments. Some of them are intended for constant employment in the imperial factories in the capital, and others are to be sent into the various provinces.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

New Railway Station at Rotherham.—The new station at Rotherham on the branch line from Sheffield of the Midland Railway Company, has just been completed and opened for passenger traffic. Messrs. Chadwick and Co., of Masborough, were the contractors who have erected the structure, which is of wood. A new road, or approach, has been made from Westgate to the station. After having obtained tickets, passengers will await the arrival of the trains in the waiting-rooms appropriated to the respective classes. The old station will now be devoted to goods, corn, &c., traffic.

Wakefield Water Works Company.—The Wakefield Water Works Company are seeking to obtain additional borrowing powers to the extent of 63,000*l.*, by application to the Board of Trade, or by an Act of Parliament. A resolution to that effect has been passed by the shareholders. The present capital of the company is 68,700*l.*, and, with the additional amount proposed to be raised, will be 131,700*l.*

The Tramways for Sheffield.—A special meeting of the Sheffield Town Council is called for December 13th next, to take into consideration the intended application of the council to the Board of Trade for a provisional order authorising them to construct a street tramway from the Norfolk Market Hall to Adereliff, Carbrook, and Brightside. A memorial to the Board of Trade to that effect will be adopted, if the proposal accepted at a former meeting be still approved.

Colliery Extension near Barnsley.—For some time past operations have been in hand in order to reach the Woodmoor seam of coal at Carlton, Hoyland, near Barnsley. The shaft having been sunk to a depth of 42 ft., the coal has at length been met with. It is about 3 ft. in thickness, and has been proved by experienced miners and various gentlemen to be one of the finest and most reliable beds of coal in the South Yorkshire district. Another shaft is being sunk, and will be completed early in the New Year. The village was put thoroughly *en fête* in celebration of the occasion, a bonfire being made of the first half ton of coal raised. The estate on which it is found belongs to Lord Wharncliffe.

The Projected Midland Railway Extension from Beauclief to Hassop.—In a recent communication I mentioned this project, and I am now further informed that the Midland authorities are thoroughly in earnest. The line of road has been surveyed and an application will be made to Parliament next session. The proposed line leaves the Midland at the point where the valley of Abbeydale begins, just before the entrance to the Bradway Tunnel. It then proceeds slightly on the upper or south side of Totley, passes under the Holmesfield and Owler Bar-road, and emerges into the valley above Baslow, a short distance below Curbar mill. Skirting the Duchess's plantation, it runs along the upper side of the village of Baslow (within a very short distance of Chatsworth Park, the residence of the Duke of Devonshire), crosses the Derwent between Bubnell Hall and Barlow Bridge, and thence proceeds to the Ambergate and New Mills branch of the Midland line with which it effects a junction near the Hassop station. This scheme will of course be a counter move to those put forward by the Great Northern and Manchester, Sheffield, and Lincolnshire Railway Companies.

Another Proposed Railway Extension.—Amongst the extension schemes, the crop of rumours respecting which is just now somewhat prolific, is one which is stated to be on foot to induce the Midland Company to extend their system to Malton, Pickering, and Scarborough. The Maltonians have held a meeting in support of this project, but as it seems to have been broached on account of the arbitrary fixing of train times by the North-Eastern Company on the occasion of the royal visit to Scarborough, I am disposed to believe that it will drop through.

The Nine Hours' Movement at Sheffield.—The nine hours' movement at Sheffield has very widely extended in that town since my last letter. Messrs. Cammell and Company (Limited), John Brown and Company (Limited), Walker, Eaton and Company, Davy Brothers, Easterbrook and Allcard, Crooks and Roberts, Hawksley, Wild and Company, George Thompson and Company, and many other firms have conceded the system, most of them to commence it on January 1st next. At some of the works the men have received permission to commence work at six a.m.; and leave at an earlier hour in the evening than at present. The Sheffield Nine Hours' League, which has thus achieved these results without a single strike resulting, holds a public demonstration in the Temperance Hall, Sheffield, this evening to thank those employers who have granted the concession, and at the same time to congratulate themselves. The conduct of those masters who refuse to grant the request of the men is also to be taken into consideration, and the course of action to be pursued in such cases decided. The system has also been adopted at the Parkgate Iron Works, Rotherham, Guest and Chrime's brass founders, Rotherham, at Staveley Works, Sheep Bridge, Renishaw, and, in fact, at all the important works in this district. Several minor wages agitations are in progress, amongst them being that of the railway draymen who ask for not more than twelve hours and 2*s.* per week advance on present wages.

Trade of the District.—The whole of the Sheffield trades and the miscellaneous branches of industry are in a most prosperous state, and there are excellent prospects of what the men term "a good Christmas."

COMPARATIVE TABLE OF THE ORDINARY LOCOMOTIVE WORKING EXPENDITURE ON THE UNDERMENTIONED RAILWAYS.

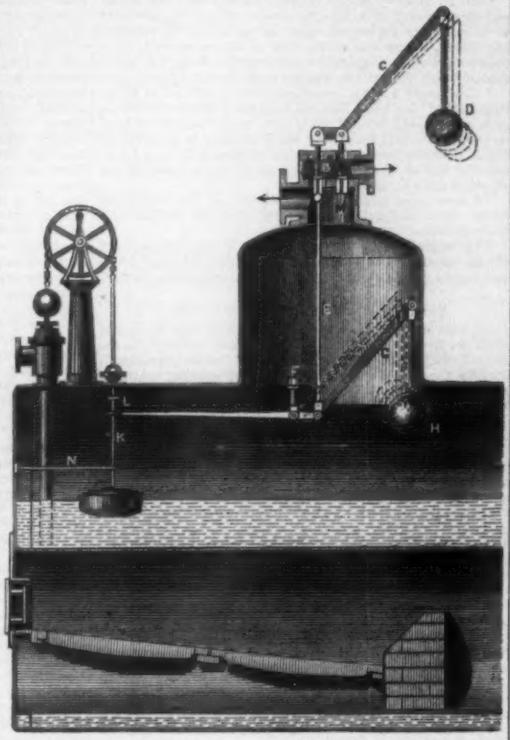
(Not including New Stock, Special Expenditure, Buildings, Stationary Engines, &c.)

Half-year ending June 30th, 1871.

| Company. | Railway earnings, exclusive of rents, steamboats, canals, &c. | Total train mileage. | | | Own engines. | | | | | Ordinary locomotive expenditure. | | | | |

MACPHERSON'S SELF-RELIEVING SAFETY VALVES.

We annex an engraving showing a portion of a boiler fitted with an arrangement of self-relieving safety valves, designed and patented by Mr. Macpherson, of the Baltic Iron Works, St. Petersburg. In the figures, A and B, are the safety valves; C is a lever bearing upon the valve, A; D is a weight for loading the lever, C; E is a rod connecting the valve B with the weighted lever G; F is the fulcrum for the lever G; H is the weight for loading the valve B, and supplying a movable point of attachment on the valve B, for the end of the loaded lever, C; J is a float for the feed apparatus; K the float rod; L the stop on float rod; N the guide for the rod K; and M the valve chest with steam and escape pipes.



It will be evident from the above description, that on the valves being regulated to blow off at a fixed pressure, should the pressure on the boiler be increased, the result of its action on the valve B would be similar to that which would be produced by adding to the weight D. This is caused by the rising of the valve B, due to increased pressure, reducing the distance between the centre of the weight, H, and the fulcrum, F, and at the same time increasing the distance between the centre of the weight, D, and the fulcrum of the lever, C, which bears on valve, A. This result is due to the angles given to the levers for loading the valves A and B, as shown by the dotted positions of the weights and levers, for each tenth of an inch the valve rises. In consequence of this arrangement, every fraction of an inch that the valve B is raised from its seat, will allow a proportionate amount of the effect of the weight, G, to be added or transferred to that of the weight D, which, acting through the lever C, on valve A, as a fulcrum, will open the valve B, thereby avoiding all danger from increasing pressure.

Should an additional weight be attached to the end of the lever C, intentionally or accidentally, it would only act on the valve A as a fulcrum, to open the valve B, thereby preventing the possibility of increasing the pressure by such means; any additional weight placed on the end of lever C, would only assist in reducing the pressure under the working load. Moreover, if the end of the lever, G, be fitted as shown in the engraving to receive the rod, K, of a water-level float I, in the event of the water getting too low, the stop L on the float rod K, would come in contact with the end of the lever G, thus counterbalancing a portion of the weight H; consequently the counterweight D, would then open the valve B, and allow the steam to escape, thereby calling attention to the state of the boiler, at the same time reducing the pressure.

It will be seen from the description we have given, that Mr. Macpherson's valves give a large area of discharge opening, while, as in Mr. Ramsbottom's well-known valves, it is impossible to overload one valve without at the same time proportionately relieving the pressure on the other. The arrangement also is such, that the condition of the valves may at all times be tested simply by swinging inwards or outwards the weight D.

INSTITUTION OF NAVAL ARCHITECTS.

The Council of the Institution of Naval Architects have issued the following circular relative to subjects on which communications are desired.

"The Council of the Institution of Naval Architects have had under consideration the question of providing a good series of contributions for their next session. They have accordingly (with the assistance of a sub-committee specially appointed for the purpose) prepared a list of subjects, which they desire to submit to the members and associates of the Institution, and others interested in shipbuilding, as questions on which they will be glad to receive communications for the Annual General Meeting in March (20th to 23rd), 1872.

"To prevent disappointment, it is requested that all such communications may be forwarded to the Secretary of the Institution not later than the 20th February, 1872; the Council cannot otherwise undertake to find a place for them in their programme of proceedings. It would also be well that gentlemen proposing to read such papers should announce their intention to the Secretary as soon after Christmas as may be, in order that he may be able to make suitable preparations for the meeting.

"In naming these subjects, it is by no means the intention of the Council to restrict gentlemen desirous of reading papers on other matters, nor is it intended that the list should be an exhaustive one."

Subjects for Papers.

1. The construction of vessels for coast defence.
2. The effect on naval construction of torpedoes, or other modes of submarine attack.
3. On the results of the best modern practice in ocean steam navigation, with reference to the latest modern improvements—such as surface condensation, super-heating, compound engines, and the like; also the value of each of these taken separately, and especially the results of any actual experiments to test this point.
4. On the friction developed in marine steam engines of different forms; and on the difference between the *gross* indicated horse power developed in the cylinder, and the *net* effective horse power available for the propulsion of the ship after working the air pump, slide valves, and other moving parts of the engine.
5. On economy of fuel in marine engines, with detailed results.
6. On marine boilers, their form, rate of combustion, and the proportion of their various parts.
7. Information as to the alleged rapid deterioration of marine boilers supplied with water from surface condensers and the remedies for the same.
8. On methods for starting, stopping and reversing marine steam engines of high power.
9. On the life and cost of maintenance of merchant steam ships.
10. The design and construction of yachts.
11. On the time allowances of yachts.
12. On legislative interference with the construction, stowage, and equipment of ships.
13. The effect upon shipbuilding of Lloyd's rules, the Liverpool rules, and the rules of other similar societies for the classification of ships; and on ships not classed.
14. On methods for the proper strengthening of ships of extreme proportions, and on the precautions necessary to insure their safety at sea.
15. On the present state of knowledge of the strength of materials as applied to shipbuilding, with especial reference to the use of steel.
16. On the masting of ships, and on iron and steel masts and yards.
17. On the disposition and construction of bulkheads, and on their attachment to the sides of iron ships.
18. On machines for the economising of labour in the construction of ships.
19. On the use of machinery for economising labour on board ship, whether merchant ships or ships of war, and whether for loading or manœuvring.
20. On the best method of clearing vessels of water in the event of a leak, and on any novel form of ship's pump.
21. On the means of accurately measuring the speed of ships.
22. On instruments for measuring and recording the rolling of ships, both as to time, and extent of roll.
23. On the measure and amount of resistance opposed to a ship's progress by the water through which it moves.
24. Exact information (either experimental or theoretical) on the efficiency of propellers.
25. On the ventilation of ships by natural and forced draughts, with details of any system in actual operation.
26. Exact information, derived from experience, on the steering of ships fitted with balanced rudders.
27. On methods of steering ships which have been deprived of their rudders.
28. On telegraphic or other communication of orders on board ship.
29. On floating structures for special purposes—such as docks, lighters, tank vessels, light ships, telegraph ships, and others.
30. On the economic value of form and proportion both in merchants vessels and in ships of war.

Charles W. Merrifield,
Hon. Secretary.

9, Adelphi-terrace, Strand, October, 1871.

STEAM NAVIGATION ON CANALS.

We publish below the Act recently passed in New York with a view to encourage and improve the condition of the canal navigation of the United States. By the conditions of this Act a premium of 100,000 dollars will be paid to the inventor of the best system of steam or other mechanical propulsion as applied to canal boats. At a meeting held last July the conditions of the trial trips were arranged by the commission appointed to investigate and report upon the subject. The conditions of the trials impose that the various competitors shall make not less than three round trips between New York and Buffalo or Oswego, and that the minimum quantity of cargo to be carried shall be 200 tons. Each competitor will be allowed to start as soon as he is ready, but the whole of the year 1872 will be devoted to the trials if necessary, and the awards will probably not be made till a much later period.

Some doubts as to the exact construction of the Act having been expressed, Mr. M. B. Champlain, Attorney-General, has issued a circular explaining precisely the points in question. First, with regard to the eligibility of tug boats, drawing cargo boats after them. It is decided that vessels of this class may be admitted into the competition. Second, with regard to the mode of propulsion. The commissioners are authorised to accept any means of propulsion or towage other than by a direct application of power upon the boat, provided that such means of propulsion does not interfere with the present method of towage upon the canal.

It is likewise stated that the experiments heretofore made in navigating canals show that freight boats propelled by steam have not been failures by reason of injury done to the banks of the canal by the swell caused either by the motion of the boat or of the wheels through the water, and the commissioners consider that there is no practical difficulty in navigating the canals by boats carrying 200 tons of cargo at the rate of three miles an hour that arises from injury to the canals or their structures. The main difficulty to be overcome is to establish the economy of steam or other motors as compared with animal power.

Chapter 868.—Laws of 1871.

An Act to foster and develop the internal commerce of the State by inviting and rewarding the practical and profitable introduction upon the Canals, of Steam, Caloric, Electricity, or any motor other than animal power, for the propulsion of Boats.

Passed April 28, 1871; three-fifths being present.

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

§ 1. George B. McClellan, Horatio Seymour, Erastus S. Prosser, David Dows, George Geddes, Van R. Richmond, Willis S. Nelson, George W. Chapman, William W. Wright, and John D. Fay, are hereby appointed a commission to practically test and examine inventions, or any and all devices which may be submitted to them for that purpose, by which steam, caloric, electricity, or any other motor than animal power, may be practically and profitably used and applied in the propulsion of boats upon the canals; said examination and tests shall be had by the said commissioners at such time or times during the season of canal navigation, for the year eighteen hundred and seventy-one and seventy-two, as they may order and direct; said commissioners shall have the right, and they are hereby expressly required, to reject all such inventions or devices, if in their opinion none of the said inventions or devices shall fully and satisfactorily meet the requirements of this Act; but said commissioners shall demand and require: 1. The inventions or devices to be tested and tried at their own proper costs and charges of the parties offering the same for trial. 2. That the boat shall, in addition to the weight of the machinery and fuel reasonably necessary for the propulsion of said boat, be enabled to transport, and shall actually transport, on the Erie Canal, on a test or trial exhibition, under the rules and regulations now governing the boats navigating the canals, at least 200 tons of cargo. 3. That the rate of speed made by said boat shall not be less than an average of 3 miles per hour, without injury to the canals or their structures. 4. That the boat can be readily and easily stopped or backed by the use and power of its own machinery. 5. That the simplicity, economy, and durability of the invention or device must be elements of its worth and usefulness. 6. That the invention, device, or improvement can be readily adapted to the present canal boats; and lastly, that the commissioners shall be fully satisfied that the invention or device will lessen the cost of canal transportation and increase the capacity of the canals. Any means of propulsion or towage other than by a direct application of power upon the boat, which does not interfere in any manner with the present method of towage on the canals, and complying in all other respects with the provisions of this Act, may be entitled to the benefits thereof; but this shall not be construed to apply to the system known as the Belgian system, or to any mode of propulsion by steam engines or otherwise upon either bank of the canals.

§ 2. No such test shall be made if the same shall in any manner retard, hinder, or delay the passage of boats navigating the canals under the present system.

§ 3. If the commissioners herein appointed shall, upon such examination and test as is provided for in the first section of this Act, conclude and determine at any time that one or more inventions or devices as aforesaid, but not to exceed three in number, shall be in all respects a full and satisfactory, practical, and profitable adaptation to the wants of the canals by reason of a new, useful, and economical means of propulsion for boats within the meaning of this Act, it shall then, and not otherwise, be their duty to grant unto the owner or owners of such inventions or devices, his or their attorney, their certificate or certificates, under their hands as such commissioners, that they have so determined and adjudged to the owner or owners of the invention or device which, in the judgment of the said commissioners, possesses in the greatest degree of perfection the requisites mentioned in the first section, they shall grant a certificate which shall be known as certificate number one; and to the

owner or owners of the next best invention or device, they shall grant a certificate as aforesaid, which shall be known as certificate number two; and to the owner or owners of the third best invention or device, they shall grant a certificate as aforesaid, which shall be known as certificate number three.

§ 4. Before entering upon the duties of his office each of the commissioners herein named shall take and subscribe an official oath, which shall be filed at once in the office of the Secretary of State. Any vacancy arising from any cause in said commission, may be filled up on the application of the remaining commissioners, by the Governor.

§ 5. The reasonable expenses of the said commission, not exceeding in all the sum of 5000 dollars, to be determined by the said board, shall be paid out of any sum which may be awarded to the person or persons receiving the certificates mentioned in the third section of this Act, in proportion to the amount awarded to the holders of said certificates, providing such certificates shall be granted; and if no such certificate shall be granted, then the same shall be paid by the Treasurer on the warrant of the Comptroller out of any moneys in the treasury not otherwise appropriated.

§ 6. Upon the production by the owner or owners, or his or their attorney, of such certificate or certificates as may be granted under the provisions of this Act, to the Comptroller, he shall draw his warrant upon the Treasurer of the State of New York for the sum of 50,000 dollars, payable to the said owner or owners of said invention, device, his or their attorney, out of any money in the treasury not otherwise appropriated, in case but one certificate shall have been granted by said commissioners. If two certificates shall have been granted and no more, then the said Comptroller shall draw his said warrant upon the said Treasurer for the sum of 35,000 dollars, payable to the owner or owners of certificate number one; and said Comptroller shall also draw his said warrant upon the said Treasurer for the sum of 15,000 dollars, payable to the owner or owners of certificate number two. If three certificates shall be granted by said commissioners, then, and in that case, the said Comptroller shall draw his said warrant upon the said Treasurer for the sum of 30,000 dollars, payable to the owner or owners of certificate number one; and one of 15,000 dollars, payable to the owner or owners of certificate number two; and one of 5000 dollars, payable to the owner or owners of certificate number three.

§ 7. If on or before the first day of November, eighteen hundred and seventy-three, the commissioners hereinbefore named shall, upon due examination, find and determine that the said invention or device has been successfully operated upon the canals, and has been or will be largely adopted as a motor on said canals by reason of its superiority over any other known method of propulsion, then, and in such case, they shall grant a further certificate of that fact, and the Comptroller, upon its presentation to him, shall draw his warrant upon the Treasurer of the State for the further sum of 50,000 dollars, payable to the said owner or owners of the said device, his or their attorney, out of any money in the treasury not otherwise appropriated; but in the case of the granting by said commissioners of more than one certificate, as stated in section six of this Act, then, and in that case, the sum of 50,000 dollars, mentioned in this section, shall be divided among and paid to the owners of the said certificates in the proportion and in the manner as stated in section six of this Act.

In answer to the many inquiries, the following information relating to the canals is given:

Dimensions of the Erie and Oswego Canals and their Structures.

CANALS.

Length of Erie Canal	351.78 miles.
Length of Oswego Canal	38 "
Width at surface of water	70 feet.
Width at bottom:	
With Slope Wall, 1 to 1	56 "
With Slope Wall, 1½ to 1	52½ "
With Bench Wall	42 "
Depth of Water	7 "

BRIDGES.

Height in clear above water line	12 feet.

LOCKS.

No. of Locks on the Erie Canal: Double, 57; Single, 15	72
No. of Locks on the Oswego Canal	18
Length of Locks, 110 ft. between hollow quoins, admitting the passage of boats 96 ft. in length.	
Width at surface of water of lower level	18 feet.
Width on bottom	17 ft. 4½ in.

AQUEDUCTS.

Width, about	50 feet.

Boats.

The following are the outside dimensions of two kinds of the largest sized boats in general use on the canals:

LAKE BOATS.

Length	95 feet.
Midship Section:	
Width at 1 ft. from bottom	17 ft. 3 in
Width 7 ft. up from bottom	17 ft. 7 in.
Depth	9 ft. 7 in.
Carrying capacity about	225 tons.
Light weight about	60 "

The above is the usual form adopted in the construction of boats of this class; they vary, however, somewhat in depth of hull.

BULL-HEAD BOATS.

Length	96 feet.
Width on bottom	17 ft. 2½ in.
Width 6 ft. up from bottom	17 ft. 8 in.
Depth of hull	9 ft.
Depth over all	12 ft. 1 in.
From the point 6 ft. from bottom to the top of hull, the sides fall in 2½ in.	
Carrying capacity about	240 tons.
Light weight about	55 "

Form of Bows.

The following from the Canal Regulations and from instructions issued by the Auditor of the Canal Department, show the shape of bow required and generally used on boats navigating the canals:

"40. In order to protect other boats and the canal banks and structures from injury, no scow or other boat, hereafter to be built and registered, shall be permitted to navigate any canal, unless the whole bow of said scow or boat be constructed of an elliptical or semicircular form, the versed sine of which shall not be less than one-fourth of the chord."

"The bow of a ship, vessel, or boat is defined to be the rounding of '*her sides* forward, beginning where the planks arch inward, and terminating where they close at the stem or prow.' In this sense the word or term is used by the Canal Board in the regulation when requiring the *whole bow*, not the top of it or deck only, to be constructed in the elliptical form designated."

"A boat constructed with a bow having the *versed sine* longer than one-fourth of the chord does not conflict with the regulation."

"The radius, where the *versed sine* is one-fourth of the chord, can always be found by multiplying the chord by 10 and dividing by 16. The result is the length of the radius."

From the Regulations of the Canal Board.

No boat drawing more than 6 ft. of water shall be cleared after the first day of June, 1864, by any collector on the Erie, Oswego, and Cayuga and Seneca Canals; and that it shall be the duty of every collector, superintendent, inspector, and weigh-master, to cause every boat found violating the regulation on this subject, to be so far unloaded as to bring her within the prescribed limits; and in every case where a boat is so unloaded, the fact shall be entered on her clearance, with a statement of the portion of her cargo taken off; and in every case where a boat shall be found drawing more water than 6 ft., as provided in this regulation, her master or owner shall be subject to a penalty of 25 dollars, to be imposed and collected by any and every collector, superintendent, inspector, and weigh-master, who may at different times and places detect such overdraft, and every collector shall enter upon the clearance the draft of water of every boat at the time of such clearance.

No boat or other craft whose height or distance from the water line of such boat or craft to the top thereof shall exceed 11 ft. 3 in.; and no loaded boat or other craft whose cargo or any part thereof, is so arranged or placed on such boat or craft, so that the top or extreme height of the same shall exceed 11 ft. 3 in. from the water line of such ladened boat or craft; and no steamboat, tug, or other craft propelled by steam, whose height when the top of the deck, machinery, fixtures, or other apparatus shall exceed 11 ft. 3 in., shall be allowed or permitted to navigate the Erie, Oswego, and Cayuga and Seneca Canals.

All boats propelled or drawn by steam, together with the boats in tow thereof, shall have preference at the locks over other boats and floats, except as otherwise provided by statute.

GLASGOW UNIVERSITY.

THE YOUNG CHAIR OF TECHNICAL CHEMISTRY.

THE Chair of Technical Chemistry, which was founded some time ago in connexion with Anderson's University, Glasgow, through the munificence of Mr. James Young, who invested the sum of 10,000 guineas for the purpose, was publicly inaugurated on last Tuesday week by the delivery of the introductory lecture by Professor Gustav Bischof, of Bonn, whose appointment to the chair we mentioned in an article in our issue for the 12th of May last. Besides being made introductory to the projected course of instruction in technical chemistry, Professor Bischof's lecture was also made the opening lecture of the day classes in Anderson's University. In the absence of Mr. Young, the chair was occupied by Mr. William Euing, past-president of the institution, who introduced the lecturer to the large audience assembled to listen to Professor Bischof's inaugural lecture.

After defining technology as being, in the widest sense of the term, the art of producing or improving all the daily necessaries and luxuries of life from natural products, Professor Bischof proceeded to divide the subject of technology into its chemical and mechanical branches, the former teaching the nature of all known bodies, as far as they are applied to practical purposes, their behaviour, how their properties are based on differences of composition, how they may be composed from their elements or more elementary combinations, or, on the other hand, extracted from compounds, and, finally, how their composition is altered under certain conditions. Technology depends upon various other sciences, such as chemistry, mineralogy, botany, medicine, &c. It is impossible to enter the field of metallurgy without a knowledge of mineralogy; it is impossible to follow up successfully the study of the various dyeing materials extracted from the vegetable kingdom without a knowledge of botany; and no one can devote himself to the consideration of the all-important questions of food and drink without a knowledge of their effects upon the animal system, which medicine alone can disclose. The lecturer incidentally referred to the history of pure and applied chemistry from the Aristotelian period down through the times of the alchemists, and stated that Robert Boyle is considered to be the first person who broke the ice, and endeavoured to free chemistry from the mercenary tendency of the former ages. He tried to work in chemistry, not as a physician or an alchemist, but as a natural philosopher, and with him commenced what may be called the recent era of the science. The alchemists and their predecessors did not know the principles, the fundamental laws of science; they wanted to apply science before they understood its principles; in fact, they did not care for science, but only for gain. Mr. Bischof selected several illustrations of the sort of subjects which will fall to be discussed in his subsequent prelections, instancing the Bessemer, Martin, and Heaton processes for the production of steel, explaining the peculiarities of each, and the conditions under which each of them is to be preferred to the others. In respect of the Heaton process he referred to some investigations recently made by Grüner, the French metallurgist, who had come to the conclusion that, on account of its greater expense, it could only be successfully employed with cheap iron ores. The lecturer then referred at some length to Mr. Henry Deacon's method of obtaining chlorine on the large scale for use in the manufacture of bleaching powder. The principle of this method consists in passing hydrochloric acid vapour in a heated state over porous bodies impregnated with a solution of sulphate of copper. The method was first described at the Liverpool meeting of the British Association last year. At that time there were such difficulties to overcome that ultimate success was rendered extremely doubtful. At the late meeting of the British Association at Edinburgh Mr. Deacon announced that he had actually overcome them. This circumstance so excited the curiosity of Mr. Bischof that he resolved at once to visit the works of Mr. Deacon at Widnes, a brief account of which he gave to his audience. Common salt is decomposed by means of sulphuric acid, in a circular salt-cake pot, in the usual way, hydrochloric acid being generated. At present this pot is charged with 15 cwt. of materials every 24 hours, this being enough for the production of 12 tons of bleaching powder per week. The hydrochloric acid gas and atmospheric air are made to pass through a series of iron tubes, in a kind of oven or chamber, in which they are heated to the degree required for the decomposition of the hydrochloric acid. This part of the process caused Mr. Deacon much anxiety, but after several modifications had been tried, the known fact that iron heated to about redness resists the action of acid vapours much better than at ordinary temperatures settled the difficulty. Before entering the decomposer the temperature of the gases is ascertained by means of a Bailey's patent adjustable pyrometer, the best results being obtained at a temperature of 325° centigrade, or about 625° Fahrenheit. The decomposer is formed of nine compartments, each 13 ft. high and 4 ft. square, filled with 3 in. marbles of burnt red clay. Mr. Deacon prefers the marbles to the bricks, which he originally employed, as they offer the least resistance, and the greatest surface to the gases, which are to re-act upon each other. The action of sulphate of copper on hydrochloric acid has not yet been explained from a chemical point of view, although several elaborate theories have been started regarding it; but certain it is that chlorine gas is liberated during the process. Formerly chimney draught was employed in order to draw the gases through the various parts of the apparatus, and on this account Mr. Deacon had to contend with another difficulty through the volatilisation of some iron with the hydrochloric acid, by which the passages of the decomposer gradually became choked up. A Roots blower was substituted for the chimney draught, and now the deposit of iron and dust can easily be driven forward by an accelerated motion of the blower. After leaving the decomposer, the chlorine gas and atmospheric air are washed, and then passed through a tower containing chloride of calcium, in order to dry them. They are then passed into the bleaching-powder chamber, where the chlorine acts upon the lime exposed to its influence. The plant at present in use at Mr. Deacon's works has been in continuous operation since the 8th of May last without showing any signs of wear and tear, turning out, on the average, 10 tons of bleaching powder per week. It is stated that by means of Deacon's new process bleaching powder can be manufactured at 2*l.* per ton less than by Weldon's well-known process. Mr. Bischof considers the Deacon process is entitled to be regarded as a practical success. Next in order, the lecturer referred to the Claudet process for the extraction of the silver and gold which are contained in the residues of the Spanish copper pyrites used in this country by the alkali makers in the production of sulphuric acid. The process is carried out as a commercial success by Mr. John Arthur Phillips, at the works of the Widnes Metal Company. By means of it 1/33rd of an ounce of silver, and 2½ grains of gold per ton of burnt ore are extracted profitably; and if the process were universally employed throughout the United Kingdom, no less than 49,000*l.* worth of silver, and 60,000*l.* worth of gold per annum could be recovered from the waste residues. These facts are based on nearly eighteen months' practical experience, and they strikingly demonstrate, in the lecturer's opinion, the fact that manufacturers cannot be sufficiently impressed with the principle that as far as possible no waste whatever should be permitted in technical processes. Besides being almost entirely lost to the country, there is every probability that the silver and gold of the pyrites, even in minute quantities, actually injure the quality of the copper which is extracted from the pyrites residues. Professor Bischof explained the chemical principles involved in Claudet's process, stating that it depends chiefly on the use of a soluble iodide, of which there is theoretically no loss. Including the loss, cost of labour, &c., the silver is extracted at the cost of 11*d.* per ounce, and taking into account the gold which is contained in the silver, the expense of working a ton of ore is reduced to 3*d.*, leaving a profit of about 3*s.* 11*d.* on each ton of ore worked. Both of the foregoing processes were fully illustrated by means of numerous specimens of the products obtained from the works at Widnes. In conclusion, Professor Bischof spoke of the question of the day, the sewage question, treating of the various methods of dealing with the liquid sewage of towns—mechanical filtration, chemical filtration, and precipitation—and incidentally noticing the good or bad features which they possess from a chemical point of view.

THE NORTHERN PACIFIC RAILWAY.—The track of the Northern Pacific Railway is now about completed across the State of Minnesota, 250 miles, the grade being wholly finished, and the track layers approaching the Red River at the rate of three miles a day. Regular trains are running over the completed sections.

THE RIVERS OF FRANCE.

M. Thomé de Gamond, the French engineer, so well known for the numerous grand projects he has from time to time made public, and whose name has long been connected with the Channel Tunnel scheme, has recently published a treatise upon the running waters of France, which evidence a great amount of labour, followed with perseverance during a long series of years. Even in 1832 M. de Gamond proposed to the French Government a comprehensive plan for the utilisation of the interior waters of the country. But at that time the spirit of co-operation for the execution of great works of public interest was not developed as it was 15 years later for the construction of railways, the carrying out then of a reform in the régime of the rivers fell entirely on the State. But in spite of the goodwill of various people in authority, whom the author had succeeded in convincing, the Minister of Finance, although much taken by the fruitful promises of the project, placed a veto upon its adoption, on account of imperative economical reasons. M. Thomé de Gamond was then obliged to renounce the realisation of his plans, but he nevertheless continued to study them out in all their details.

In 1843 a certain public movement towards the pursuit of great enterprises induced the author to present anew his work to the Government. But it was objected that the great project would be entirely obnoxious to the railway interests.

The same under the Republic of 1848, and under the Empire: the Ministers of Public Works successively examined the question, and unanimously praised the perseverance and industry of the engineer, but they all urged the impossibility of carrying out so great a work before the *réseau* of railways was completed.

In 1862 M. Thomé de Gamond brought his project before the public in a series of ten articles published in *La Patrie* under the title of "The Rivers of France." The engineers charged with the various hydraulic services of the departments, for the most part approved the simplicity of the proposed plan. This reform appeared to them the more acceptable because it was the practical generalisation of methods proved separately and by experience. But the approbation of the engineer was not sufficient to insure the execution of the project, and to-day the auther comes forward again to submit it to the consideration of all those who have the prosperity of France at heart, hoping that in the presence of such promising results the spirit of co-operation so fully developed in his creation of railways, will not be wanting for his scheme.

What this scheme is, we may gather from M. Thomé de Gamond's essay, upon the required reform in the general régime of the inland waters.

Instability is the principal inconvenience in the actual condition of things. The waters flow in the upper effluents down steep slopes into the great collecting rivers, which generally present but a slight fall. It results from this condition, that the feeding streams situated far up streams empty themselves rapidly, by reason of their velocity in times of flood, whilst the waters accumulated lower down spread themselves over the land causing frequent inundations. The harvests in the upper plains are then made barren through dryness, whilst the lower valleys of the rivers are flooded. This disordered state of things arises solely from the natural irregularity in the profile of the inclined plane along which the flow of the waters takes place towards the ocean.

The works already undertaken to improve the natural régime, are sufficient to prove the immense resources that could be developed. There are plenty of examples to show the benefits that are to be obtained by the utilisation of the rivers, and no inventions are required to put into use these treasures of force and fertilisation. It is enough to appreciate and to imitate the results already obtained, in generalising upon a comprehensive plan applicable to the entire country, the practice undertaken at home and abroad.

M. Thomé de Gamond proposes to suppress the natural profile of the large watercourses which are imperfect, and to substitute for them a series of regular planes in successive slopes. This would be, in other terms, the transformation of the inclined planes of rivers into hydraulic staircases. The full régime would be maintained in those rivers where, in the natural state of things, the water is sometimes deficient, and sometimes in excess. For this purpose the overflow would be regulated by dams for the retention and distribution of the water, and there would descend to the sea only that portion which would be in excess after it had fulfilled all the numerous useful purposes for which it would be destined. Spacious reservoirs would also be established at the higher levels for storing up a portion of the superabundant rain water, to utilise it during dry seasons. These reservoirs would form lakes some miles in length, and of variable width, enclosed in valleys, and containing water 60, 80, or 100 ft. deep.

The rivers of France, from their source to the sea, would be divided into a multitude of reaches, maintained by weirs, a system well known upon many canalised streams. The régime of outfall being thus distributed among basins at constant levels, it would be easy to regulate the different hydraulic systems according to the available supply, the irrigation of land, the motive power in the various falls, the navigation, &c. The necessary precautions against inundations would be much simplified, and would be reduced to measures partly administrative. Extreme velocities would be suppressed in the river beds, where the slopes were heavy, to be localised carefully in the various weirs, when they would produce immense hydraulic power now lost, to the benefit of every kind of industry. The current being almost entirely on the surface of the water, the disintegration of the banks, and the encumbering of the beds of rivers, would be avoided. At the higher levels floods would be unknown, and the denudation of the ground, so fatal to agricultural property, would cease.

M. Thomé de Gamond gives a general Table of the various rivers in France, classified by their natural basins. Abstracted, this Table is as follows:

Name of Basin.	Area in square miles.	Population in thousands of inhabitants.	Total length of the river in miles.	Mean slope in parts per 1000.	Mean volume of diurnal rainfall in millions of cubic feet.	Mean volume of diurnal discharge into the sea in millions of cubic feet.
Seine	28,606	6,867	9,139	0.96	1,645,615	761,799
Loire	42,604	6,853	20,059	1.25	2,688,130	1,096,170
Gironde	33,503	5,062	17,469	2.86	2,621,060	1,311,359
Rhône	36,506	6,237	10,918	2.28	3,308,774	1,914,530
Rhine	14,193	2,969	8,633	1.08	974,280	269,622
Escaut	1,202	1,044	715	0.53	71,094	106,651
Manche	16,706	4,499	5,094	2.09	1,345,671	293,907
Ocean	18,287	3,181	8,930	0.92	1,430,436	386,676
Mediterranean ...	10,836	1,463	3,737	3.15	637,906	205,164
Totals...	202,431	36,284	81,693	1.57	14,722,956	6,348,958

The total volume discharged into the sea is about 180 milliards of cube metres, corresponding at the rate of 140,000 cube feet to the acre, to the irrigation of 45,000,000 acres, if the whole of this volume was employed in irrigation. This same volume could furnish by its fall the enormous amount of 12,000,000 of horse power. Both these questions of irrigation and power are studied by M. Thomé de Gamond. He shows that France lacks meadow lands, that she could lay out immense areas to receive irrigation, that by increasing the number of cattle raised more manure would be available for the cultivation of cereals. He calculates that a rent of 16 francs per acre per annum could be obtained for irrigation.

The chapter on motive power shows that there exist in France about 40,000 dams, and that there would be established an equal number of new dams, having an average fall of 10 ft., each able to furnish, after deducting the due proportion for irrigation, a mean force of 40 horse power. Industrial establishments could thus spread themselves over the whole surface of the country under the most favourable conditions, the use of steam would be reduced to very narrow limits, and the exhaustion of coal supplies would become a question for the remotest consideration. It is proposed by the author to fix the rent of each horse power at 72 francs per annum.

Considering, then, the condition of the present régime, and passing on to review the various means suggested to improve it, M. Thomé de Gamond proposes to raise the level of the outfall of oceanic rivers, very sensibly, 2 ft. for example, by means of a dam interposed transversely across the embouchure of the river. These dams would be monolithic, raised above the beach, and intended to hold back the sea within the limits of its own domain. The sea, spreading out at the foot of these structures, would deposit shingle and sand along its whole length. The volume of water in the river reduced by that amount taken for irrigation, and regulated by the high-level reservoirs, would discharge itself over the crest of the dam, and at low water by sluices.

The access to the great sea ports of France would then be improved for ships of heavy tonnage, and the great river harbours would be opened for navigation by transforming the sea channels into vast lakes of fresh water independent of the sea. The ebb and flow of the tide would be suppressed. An outer port accessible in all winds would receive the ship between two jetties running obliquely from the shore, and they would communicate by locks with the upper level of fresh water. The internal navigation would be found also greatly improved, all the reaches being always kept full of water from their sources to the sea. Great lines of water communication could also be completed, and thus an important auxiliary to the railways would be formed. The maximum level being assured in all the reaches by the construction of the proposed dams, it would only remain to connect the former by locks. It would be necessary to have about 4000 locks to open a navigable system of more than 18,000 miles, to which would be added the 2500 miles of imperfect canals which France to-day possesses. At the rate of 80,000 francs for each lock, the cost would amount to several hundreds of millions.

Fish culture could be introduced on a grand scale in the improved rivers, and from this source alone, according to the author, an enormous revenue would be derived. It is urged that inundations could be successfully prevented were the proposed measures carried out, thanks to a system of regular discharge, and to the means taken for the storing up of the rain water in the upper valleys.

Up to the present time the various problems which we have thus passed under review have only been worked out independently. Thus there have been executed the necessary works for the utilisation of rivers for the supply of cities, for obtaining motive power, for irrigation, and for navigation, whilst in isolated cases the means for defence against inundation have been carefully studied. But nothing approaching a general and comprehensive scheme has ever been developed, and the rivers lose themselves in the sea without being utilised. It is urged that the absence of the spirit of co-operation has hitherto prevented this reform, and it is proposed that in each of the basins named above, a powerful company should be formed analogous to that of the railway companies. These companies would have no cause for demanding State subsidies, because the enterprise would become highly profitable. They would have each the development of the various water services under the control of the State; they would have to pay to Government annually one-tenth part of their receipts; they would possess entire control of the management; and at the end of a concession of a century's duration the whole of the works would revert to the State.

The whole of the expense for 40,000 dams, 4000 river locks, and 262 marine locks, the acquisition of lands, the construction of irrigating canals and conduits, the buildings, machinery, earthworks, &c., would of course be enormous. The annual receipts derived from irrigation, power of navigation, fish culture, &c., are assumed to amount to 550 millions of francs, a sum which would largely repay for the capital invested. Such is the magnificent scheme which M. Thomé de Gamond has once more brought forward. It is a scheme at which he has carefully laboured until he has developed its closest details, and the advantageous results anticipated are possibly not overdrawn. But it is to be feared that, even while comprehending the grand development of prosperity that even the partial execution of this project would bring about, public opinion will remain almost indifferent to propositions. And at present France, having the utmost need of energy in pushing forward in the path of progress, is yet paralysed in her efforts by the rigid exigencies of necessity.

Vienna Exhibition Building.—The tender of Herr Harkort, of Westphalia, has been accepted for the construction of the Vienna Universal Exhibition building, which will be formed of iron, after plans supplied by Mr. Scott Russell. Tenders were invited from the Fairbairn Engineering Company, the Butterley Company, the Forges et Chantiers de la Méditerranée, MM. Schneider, of Creusot; the Fives-Lille Company, the Cockerill Company (Seraing), &c. The Harkort tender was, however the most moderate.

BAUSCHINGER'S INDICATOR EXPERIMENTS ON LOCOMOTIVES.

(Concluded from page 245.)

4. Water and Steam Consumption.

We have already pointed out, in a former article, the marked discrepancy existing between the theoretical curve of expansion, as laid down according to the various laws, and the actual expansion curve drawn by the indicator; and we explained, at the time, that this phenomenon was mainly due to the heat which is received by the expanding steam from the cylinder. Before proceeding further, we shall now investigate this peculiar action of the steam during the period of expansion in greater detail. Suppose the steam to be in a perfectly dry and saturated state at the commencement of the expansion, we shall find, if we follow the actual expansion line, that, by abstracting a certain quantity of heat from the cylinder, the contained steam has become superheated; if we then apply the law of Mariotte-Gay-Lussac to the expanding steam in this superheated state, the course of the actual expansion curve would lead to extraordinary high temperatures, in order that the existing pressures should be accounted for. As an example, we will take the diagram, represented in Fig. 23, on page 151, and assuming the steam to be quite dry and saturated at the commencement of expansion, marked *a* in the diagram, its temperature for the corresponding pressure at a point, *e*, would have to be not less than 482 deg. Fahr. The fallacy of this theory being evident, we must search for other arguments to account for the revelations of the indicator, and we are consequently led to conclude that the steam is, in reality, in a *wet* state at the commencement of the expansion; also, that a sufficient amount of heat can be obtained from the cylinder, so that, by the re-evaporation of the water combined with the steam, its pressure can be maintained at the height of the actual expansion line. Referring again to the diagram just mentioned, we will next suppose the steam to contain 20 per cent. of water at the point of cut-off, and following its action it will now be found that at a point, marked *b* in the expansion curve, this amount of water has been completely dried or evaporated; from this point, therefore, the steam would, of course, pass into the superheated state, and applying again the perfect gas theory to the steam expanding in such a state, the result would represent, at a point marked *d* in the diagram, the enormous temperature of 422° Fahr. The acceptance of but 20 per cent. of water is consequently insufficient, and in the particular case of diagram, Fig. 23 on page 151, the water contained in the steam must have been much more than this quantity; in fact, to account for the additional work performed, as shown by the elevation of the actual expansion curve until a point, *e*, is reached (marking the opening of the exhaust valve), the steam must have contained at least 35 per cent. of water at the commencement of the expansion.

But the question of the precise quantity of water contained in the steam is not so easily determined, and no direct means of ascertaining the nature of the steam in this respect, being at the disposal of the experimenters, Professor Bauschinger proceeded in the following way: The theory of mechanical heat gives a formula by means of which the specific volume of saturated steam can be measured from its corresponding pressure; by the aid of this formula—the correctness of which has since been verified by the experiments conducted by Fairbairn and Tate—Zeuner computed his tables concerning the properties of saturated steam. To measure now the amount of steam expended in producing a certain power, we should first mark in the diagrams, obtained during a run, all the leading points of the steam distribution, as commencement of admission, expansion, release, and compression, and then ascertain the quantities of steam contained in the cylinder at these respective points, presupposing, however, that the steam was in a dry and saturated state. In most cases, the exact point of admission cannot be decided with sufficient accuracy; but, as regards the other elements, it will be found that in the case of diagram, Fig. 23, on page 151, the cylinders contained per revolution 0.527, 0.890, and 0.334 lb. of steam at the commencement of expansion, release, and compression respectively; in the next diagram, Fig. 24 on the same page, the relative contents in the cylinders will be 1.333, 1.520, and 0.246 lb. of steam per revolution. As regards the first two of these figures, viz., the quantities of steam contained in the cylinder at the commencement of expansion and release respectively, they should be the same, as the weight of the steam undergoes no change during the period of expansion; but owing to the process of condensation and re-evaporation, which has taken place in the cylinder, the indicator diagram nearly always shows a greater quantity of steam exhausted than received. Thus, in the case of diagram, Fig. 23, on page 151, the quantity of water evaporated during expansion will be obtained by subtracting the weight of the steam at the commencement of expansion from that of the steam at commencement of release, assuming that the steam was at this latter point in a perfectly dry state; consequently, 0.890 − 0.527 = 0.363 lb., equal to 40 per cent. of the weight of the total amount of steam present in the cylinder at the commencement of the release. Next, in order to obtain the amount of steam used per revolution of driving wheel, the quantity of steam retained in the cylinder when the escape is cut off, and which is therefore compressed into the clearance spaces, should be deducted from, either the quantity of steam contained at the beginning of expansion, or that contained at the beginning of release; thus, in the above example, we shall find 0.527 − 0.334 = 0.193 lb., and, in the second case, 0.890 − 0.334 = 0.556 lb.

By calculating in this manner the steam consumption during an entire run, and by measuring at the same time the quantity of water used, the difference existing between these amounts will express the quantity of water contained in the steam, affording thus a close approximation as regards the real state of the steam immediately before the commencement of the periods of expansion and release. These calculations were made by Professor Bauschinger on each run; the method followed during these computations being similar to that employed for ascertaining the total amount of work developed on a run, as described by us on page 245. We give, in subjoined Table No. VIII., these data, some of which, we should mention, appertain to the same indicator curves as already put together on page 52, while the Table No. IX., on the next page, shows the work developed by 1 lb. of steam as obtained in the different engines and for various degrees of expansion.

It will be seen, by glancing over columns O and P, of Table No. VIII., that for similar conditions of working the respective figures differ little from each other; but, on the other hand, the amount of "throttling" given in columns D and E, will materially affect these figures. We have already shown why the figures contained in column M give a nearer approximation to the true consumption of steam than those of column L, and consequently the results in column P should be taken as a criterion by which to judge the action per pound of steam; it will be noticed that, in the case of both engines, the figures given in this column are diminished as the amount of wire-drawing or throttling increases.

In computing, on the other hand, the results given in Table No. IX., only such experiments have been selected during which the regulator was kept practically full open, and in order to establish the comparative action of the steam in the different engines, the average of the figures corresponding to the last two columns of the foregoing Table was multiplied by the constant factor $\frac{1}{4} \times$ piston area $\times$ stroke, the results thus expressing the amount of work done by 1 lb. of steam. These results, it will be observed, furnish some curious and interesting data regarding the action of the steam. Thus referring to the first four engines with the shifting link motion, it appears that the advantages of expansive working are materially impaired by the

TABLE VIII.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Class of engine.	Period of admission in per cent. of stroke.	Number of revolutions of driving wheel per minute.	Pressure in pounds per square inch.					Steam contained in cylinder in pounds per revolution.			Consumption of steam per revolution.		Mean effective pressure in pounds per square inch.	Column N ÷ column L.	Column N ÷ column M.
			In boiler.	Maximum during admission.	At beginning of expansion.	At beginning of release.	At beginning of compression.	Before expansion.	Before release.	Before compression.	Calculated from columns I and K.	Calculated from columns J and K.			
	per ct.	rev.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.		
		142	116	115	102	34	9.5	0.58	1.02	0.38	0.20	0.63	37	185	59
		125	114	113	103	33	9	0.59	0.99	0.38	0.20	0.61	36	182	62
		147	113	100	89	28	5.5	0.52	0.89	0.32	0.20	0.57	35	175	61
		124	98	98	90	28	5.5	0.53	0.89	0.33	0.19	0.56	36	187	64
		119	94	90	84	26	6	0.50	0.85	0.33	0.16	0.52	30	179	58
		124	117	113	103	34	10	0.59	0.99	0.39	0.19	0.59	36	187	61
		136	106	88	76	23	5	0.46	0.78	0.30	0.15	0.47	27	174	58
		132	111	84	70	21	5.5	0.43	0.72	0.33	0.10	0.39	21	202	55
		120	85	82	73	21	3.5	0.45	0.74	0.28	0.16	0.45	27	166	60
		140	83	80	73	23	4.5	0.45	0.74	0.31	0.14	0.43	26	184	60
		134	105	74	65	18	3.5	0.40	0.67	0.29	0.11	0.37	23	209	62
A	16	117	111	61	54	14	2.5	0.35	0.57	0.28	0.07	0.29	19	228	62
		147	88	50	43	9	3	0.29	0.50	0.28	0.01	0.21	10	333	50
		115	114	36	30	4	2	0.23	0.40	0.27	...	0.13	4	...	31
		120	107	107	98	33	5.5	0.56	0.98	0.32	0.24	0.66	43	178	65
		140	72	59	49	14	3.5	0.33	0.60	0.29	0.03	0.30	16	457	53
		144	71	38	33	6	3	0.25	0.44	0.28	...	0.15	7	...	47
		146	92	57	51	12	4	0.34	0.57	0.30	0.04	0.27	14	350	52
		139	90	78	70	21	5	0.43	0.75	0.31	0.11	0.43	24	209	56
		137	73	72	65	17	3	0.41	0.66	0.28	0.12	0.37	24	195	65
		133	80	66	59	16	3.5	0.38	0.65	0.29	0.08	0.35	20	235	57
		129	85	80	73	25	4.5	0.45	0.81	0.31	0.13	0.50	28	201	56
		126	93	89	82	25	6	0.49	0.82	0.33	0.15	0.49	31	197	63
		122	73	70	65	20	5	0.41	0.72	0.31	0.09	0.40	23	250	57
		148	86	86	81	10	4	0.34	0.53	0.03	0.30	0.50	30	98	60
		121	80	77	73	9	2	0.31	0.51	0.03	0.28	0.48	28	99	58
		83	77	73	71	10	3	0.31	0.53	0.03	0.27	0.50	28	100	55
		173	78	70	67	7	3	0.29	0.47	0.03	0.26	0.44	25	95	57
		172	78	66	64	6	3.5	0.28	0.45	0.03	0.25	0.42	23	91	55
		109	86	80	74	10	2.5	0.32	0.55	0.03	0.28	0.51	32	111	62
		197	62	55	50	4	3.5	0.23	0.42	0.03	0.20	0.38	16	80	41
		169	66	21	19	−6	0	0.12	0.21	0.02	0.10	0.18	2.5	24	13
E	12.6	167	85	80	78	10	4	0.33	0.51	0.03	0.29	0.48	29	101	60
		155	57	49	47	2.5	2.5	0.22	0.37	0.03	0.19	0.34	16	82	47
		144	81	72	69	9	3.5	0.30	0.50	0.03	0.26	0.47	26	97	55
		132	83	68	65	8	4.5	0.28	0.48	0.03	0.25	0.45	21	80	47
		179	58	44	41	3	2	0.20	0.37	0.03	0.17	0.34	15	85	44
		169	70	11	9	−8	0	0.09	0.16	0.02	0.06	0.13	−2.5	...	...
		159	71	24	22	−5	0	0.14	0.21	0.02	0.11	0.18	5	44	27
		156	69	16	14	−7	0	0.11	0.18	0.02	0.08	0.15	1	12	6
		204	58	46	43	2.5	2.5	0.21	0.37	0.03	0.17	0.34	13	79	38

moist nature of the expanding steam. The same phenomenon is also demonstrated by the relations of columns 12 and 13 with column 20 of Table No. VII., published on page 249. Finally, by comparing the results recorded in Table No. IX. for the different engines of the shifting link and of the double valve motion class respectively, the duty given off per pound of steam is seen to be considerably higher in the former engines, a fact which corroborates the statements already made concerning the relative merits of the two systems of valve motion, and according to Professor Bauschinger, the balance in favour of the shifting link motion appears to be due essentially to the action of compression. It should be remembered, however, that the results computed in Table No. IX. are based on the supposition that the steam is in a dry state; on the other hand, it is evident that the nature of the steam is greatly influenced by the degree of expansion, so that in this respect, experiments on engines fitted with variable expansion gear generally can merely furnish approximate results.

TABLE IX.

Class of engine.	Number of notch.	Period of admission. Apparent admission in per cent. of stroke.	Period of admission. Actual admission in per cent. of stroke.	Duty performed per pound of steam. According to column (O) of Table VIII.	Duty performed per pound of steam. According to column (P) of Table VIII.
		per cent.	per cent.	foot-pounds	foot-pounds
A	1	15	20	287,000	89,000
	2	22	27	164,000	92,000
	3	30	34	136,000	88,000
	4	43	46	98,000	83,000
	5	51	54	88,000	79,000
	6	57	59	82,000	74,000
	7	62	64	79,000	75,000
	8	74	75	65,000	66,000
B	1	19	24	158,000	97,000
	2	26	30	136,000	92,000
	3	34	38	110,000	86,000
	4	44	47	98,000	83,000
	5	62	64	77,000	71,000
	8	78	79	56,000	56,000
C	3	36	40	108,000	86,000
	4	42	46	99,000	83,000
	5	49	52	90,000	79,000
	6	55	58	83,000	79,000
D	2	20	25	182,000	103,000
	3	28	32	141,000	95,000
	7	60	62	68,000	64,000
E	1	12	18	112,000	63,000
	2	15	20	114,000	63,000
	3	21	26	95,000	60,000
	4	29	33	92,000	68,000
	8	90	98	33,000	30,000
F	1	23	27	86,000	63,000
	2	28	33	77,000	58,000
	3	36	40	74,000	61,000
	4	47	51	70,000	66,000
	8	85	86	53,000	49,000
G	1	30	34	90,000	70,000
	2	39	42	82,000	68,000
	3	57	60	68,000	65,000
	4	97	98	42,000	42,000
H	1, II	21	27	107,000	78,000
	2, „	30	36	99,000	79,000
	3, „	38	43	86,000	78,000
	4, „	43	48	79,000	74,000
	5, I	45	50	72,000	65,000
	6, II	48	52	75,000	68,000
	8, I	75	77	56,000	58,000
	8, II	87	88	49,000	50,000

In conclusion, it will be seen that in the case of locomotive engines, the circumstances which have to be contended against in conducting reliable indicator experiments are of a very difficult nature. Our abstract, which we have now completed from the extensive reports of Professor Bauschinger and Herr Zorn, will give some idea of the labour that has been bestowed by the experimenters upon their work; while, on the other hand, the results of these experiments show fully the amount of useful information afforded by the revelations of the indicator.

THE SEWAGE AT BIRMINGHAM.

(*Continued from page 308.*)

HOLDEN'S process, which consists in adding to the sewage a mixture of sulphate of iron, lime, and coal dust, calls for even less notice than the chloride of iron process, inasmuch as, from the results of a trial with the sewage of 130,000 people at Bradford, its effect appears to be to actually increase the quantity of putrescible matter in the sewage, while separating a totally worthless deposit. The Corporation of Bradford has abandoned this process, and handed its sewage over to the Peat Engineering and Sewage Filtration Company for treatment. It will be necessary to wait the result of this experiment before pronouncing any definite opinion as to the value of this company's method of purification. Bird's process has been tested at Stroud and Cheltenham. By this process the sewage is first treated with crude sulphate of alumina, and then filtered through three coke filters. The sulphate of alumina is prepared by adding 120 lb. of sulphuric acid to 6 cwt. of pulverised clay. This mixture suffices for treating from 150,000 to 200,000 gallons. The Rivers' Pollution Commissioners report that, although the sewage is much improved, yet it is not sufficiently purified to be safely admitted into a running stream.

Lenk's process affects a very satisfactory precipitation of the offensive ingredients of the sewage. In fact gold fish put into the purified sewage lived for some weeks. The expense of this process as tried at Tottenham was found to be at the rate of 6*l.* 10s. per week for chemicals sufficient to disinfect about 700,000 gallons of sewage per day. The Tottenham Board of Health discontinued the use of this process on account of the expense attending it, and the uncertainty as to the value of the manure. Forbes's process is now being tried on a comparatively large scale at Tottenham, and, as far as can yet be judged, with very satisfactory results. Dr. Voelcker says:—"Any person who has once seen the extremely rapid and simple process by which foul raw sewage is defecated and clarified by this plan, cannot but be struck with the rapidity and efficient manner in which raw sewage is rendered almost as clear and inodorous as ordinary water." For carrying out this process phosphate of alumina is dissolved in sulphuric or hydrochloric acid, and the resulting solution is mixed with the sewage, in such a proportion as gives about 35½ cwt. of phosphate to each million gallons of sewage. The disinfecting fluid has a very powerful action in arresting decomposition, so much so that the deposit can be dried without much offence to the neighbourhood. The effluent water is not only incapable of causing annoyance, but is actually more fertilising than the raw sewage, by reason of the valuable manurial properties of the added phosphate. If, however, the sewage be not intended for use in irrigation, a further treatment with milk of lime is necessary, after which the sewage is filtered through coke or some other carbonised substance. The quantity of lime used is about 18 cwt. per million gallons of sewage. The phosphate costs about 3*l.* 10s. per ton. Further trials can alone determine the commercial value of this process.

Sillar's process, more commonly known as the A. B. C. process, from the initial letters of the ingredients of the precipitant, namely, alum, blood, clay, and charcoal, has been often described. The report of the Rivers' Pollution Commissioners on this process says:—"Our investigation into Sillar's, or the A. B. C. process of treating sewage, as carried out at Leicester and Leamington, extending over nearly two years, has led us to the following conclusions:

"1. The process removes a large proportion of the suspended impurities from sewage, but on no occasion, when we have seen it in operation, has this removal been so complete as to render the effluent sewage admissible into running water.

"2. The A. B. C. process removes a very small proportion of the soluble polluting matter from sewage. After treatment, the effluent sewage is very little better than that which is obtained by allowing raw sewage to settle in subsidence tanks.

"3. The manure obtained has a very low market value, and cannot repay the cost of manufacture.

"4. The manipulations for the extraction and drying of this manure are attended with a nauseous odour, especially in warm weather, and would occasion a serious nuisance if the works were situated in or near a town."

It is only fair to state that, notwithstanding this very damaging report, this process is still being experimented upon. At Crossness works are being erected to treat 500,000 gallons of sewage per day as an experiment; at Southampton for the treatment of 2,000,000 gallons; and at Bolton and Leeds.

The Birmingham Committee, however, report emphatically against the adoption of this process for disinfecting the sewage of their town.

Having thus reviewed all the best known processes for chemical precipitation, the committee proceed to give the results of their researches into the merits of the various filtering processes: meaning, of course, filtration through artificial filters, not through the land as a natural filter.

The space at our command does not permit more than a glance at this part of the report. More is scarcely necessary, as all processes of this kind have hitherto signally failed.

The first process spoken of is that known as Weare's. This consists in first passing the raw sewage into a subsiding tank, and then causing it to pass through another tank filled with coarse cinders and charcoal. Afterwards the partially clarified sewage flows through a sort of cage filled with charcoal. Having passed this cage, the sewage is put through three filters. The first is charged with a mixture of fine charcoal and washed cinders, placed between plates of perforated galvanised sheet iron. There are two other deodorisers of the same kind, but filled with finer materials; coke, ground to the size of peas, being the charge of the third filter of the whole series. In this last filter a cloth takes the place of the perforated plates. In large operations it is proposed to filter upwards, so as to dispense with the filter cloths. The Birmingham Committee inspected this process at work at the workhouse at Stoke. They obtained some of the raw sewage, and some of the effluent water. These they caused to be analysed by Dr. A. Hill, F.C.S., the Birmingham borough analyst. Dr. Hill gives the following as the result. He found that the suspended matters were almost completely removed, as might be expected from the use of the filter cloth. The dissolved organic carbon and nitrogen are considerably diminished, but every other ingredient, except oxide of iron and alumina, is greater in quantity in the effluent than in the raw sewage. Dr. Hill remarks that he can only account for this by supposing that the filters were already charged with a large amount of contamination, which impregnated the comparatively weak sewage which was then being filtered. This is the more probable as a heavy storm occurred just before the collection of the sewage analysed. Dr. Hill gives the following details of his analysis.

Description.	Parts per 100,000		Grains per imperial gallon.	
	Raw sewage.	Effluent sewag	Raw sewage.	Effluent sewage.
Analysis of Dissolved Matters.				
Organic carbon	3.50	4.33	2.45	6.19
Organic nitrogen	0.96	1.47	0.67	2.11
Ammonia	7.00	2.80	4.90	4.00
Nitrogen, as nitrates and nitrites	2.76	0.00	1.53	0.00
Total combined nitrogen ...	9.48	3.78	6.93	5.40
Chlorine	7.09	3.47	4.96	4.96
Sulphuric acid	16.56	4.78	11.59	6.55
Silica	1.36	0.89	0.95	1.28
Oxide of iron and alumina ...	4.61	4.67	3.22	6.68
Phosphoric acid	a little	a little	a little	a little
Lime	8.28	3.94	5.79	5.78
Magnesia	1.79	1.20	1.25	1.72
Potash	3.22	1.85	0.45	2.64
Soda	10.09	3.56	7.06	5.07
Suspended Matters.				
Mineral	0.0	47.39	0.0	67.70
Organic	0.0	38.57	0.0	55.10
Total suspended matters ...	0.0	85.96	0.0	122.80
Total dissolved matters ...	77.50	33.11	54.25	47.30
Total solid matters dissolved and suspended	77.50	119.00	54.25	1700.0

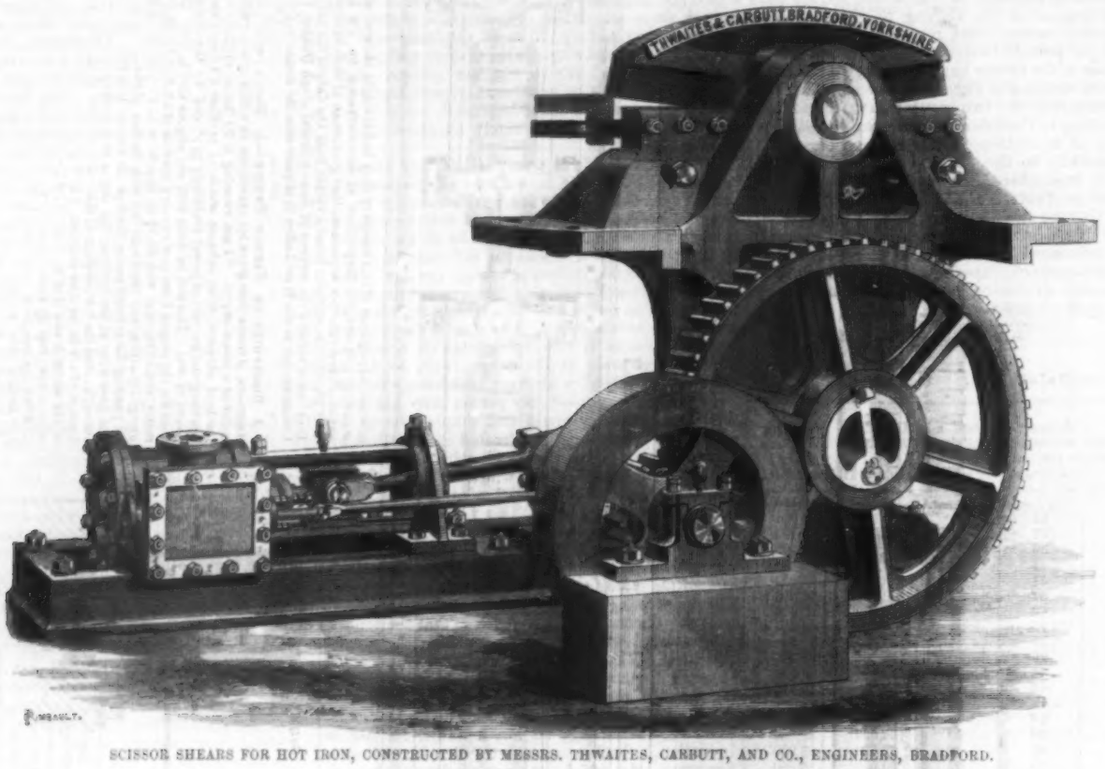
An attempt to purify the sewage of Ealing by filtration through coarse vegetable charcoal failed completely. In fact an injunction from the Court of Chancery put a stop to the process. This cannot be wondered at when the following figures are inspected: The raw sewage contained 41 grains of solid matter per gallon, of which 6.75 were organic. The filtered sewage contained 36 grains per gallon, of which 5.4 were organic.

Having all this evidence of the shortcomings of all known processes of precipitation and filtration before them, the Sewage Inquiry Committee went to work and collected the most exhaustive information on the two remaining alternatives—irrigation which aims only at purification, and irrigation which aims at commercial utilisation of the manurial properties of the sewage. This part of the report contains most valuable information in the shape of reports from eminent authorities, the personal investigations of the committee, and the testimony of witnesses examined. The whole extends over a very large number of pages, and is necessarily somewhat verbose. We hope, however, to give a succinct analysis which shall omit no really important point, while placing all the facts in a small compass.

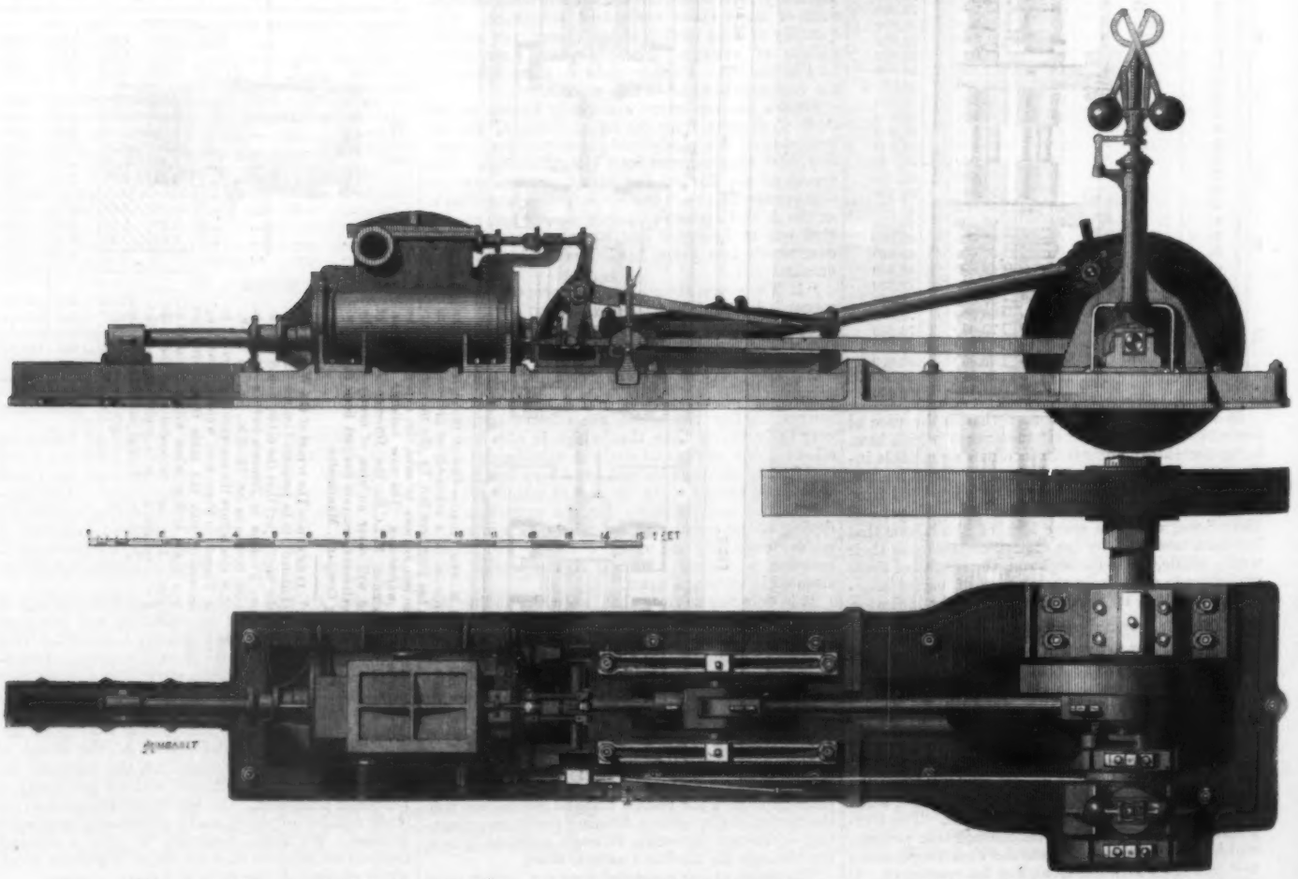
(*To be continued.*)

SHEARS AND ENGINE FOR FORGE TRAIN AT THE BRITANNIA WORKS, MIDDLESBROUGH.

(*For Description, see Page* 321.)



SCISSOR SHEARS FOR HOT IRON, CONSTRUCTED BY MESSRS. THWAITES, CARBUTT, AND CO., ENGINEERS, BRADFORD.



ENGINE FOR DRIVING FORGE TRAIN, CONSTRUCTED BY MESSRS. MARTIN SAMUELSON AND CO., ENGINEERS, HULL.

FORGE TRAIN AT THE BRITANNIA WORKS, MIDDLESBROUGH.

CONSTRUCTED BY MESSRS. CLARIDGE, NORTH, AND CO., ENGINEERS, BILSTON.

(*For Description, see Page* 321.)

FIG. 1.

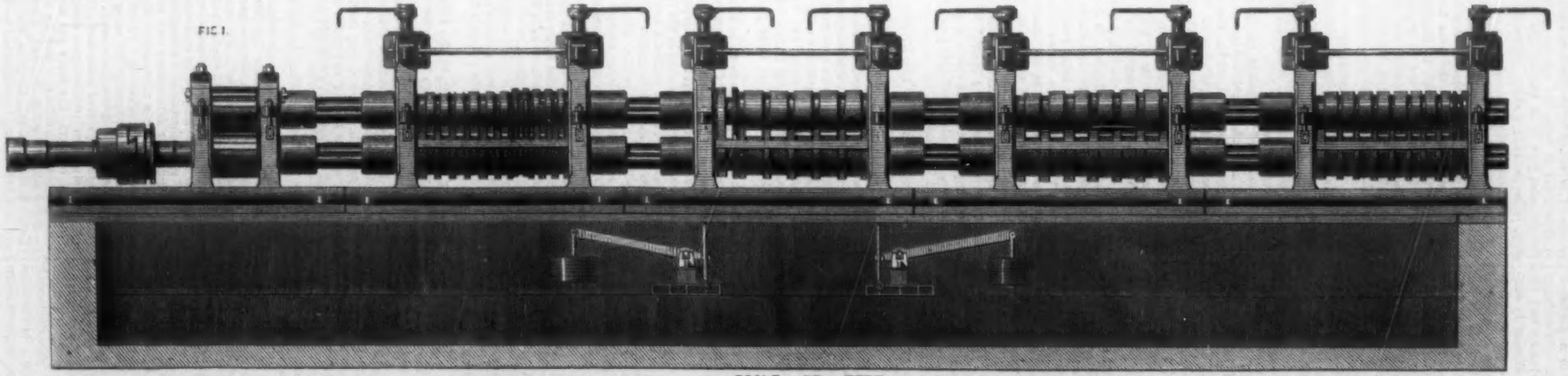
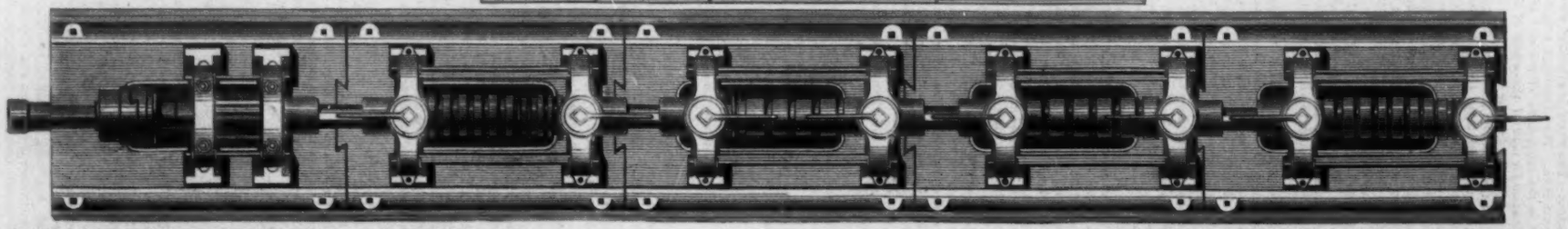


FIG. 2. SCALE OF FEET.



Fireproof Custom House for Monte Video.—One of the objects of the recent Uruguayan Loan was the erection of a commodious fireproof Custom House at Monte Video. The want has long been felt by the mercantile community, and the Government are no less anxious to save the expense of the present system of widely-scattered warehouses. The new building has been designed by Mr. Alexander Mackinnon, M.I.C.E., the Director-General of Public Works in the Republic, and will cover an area of nearly 400 ft. by 150 ft., and the ironwork for this extensive structure has just been contracted for with the Fairbairn Engineering Company, Manchester.

The West India and Panama Telegraph.—The report of the West India and Panama Telegraph Company (Limited), to be presented on the 22nd inst., states that the hopes expressed in the last report that the cable would be successfully laid by the contractors from Panama to Jamaica have not yet been realised. That portion of the cable was broken in lat. 14 12 N., long. 77 45 W., and has not yet been recovered. After this failure the contractors proceeded to lay the section of the cable from St. Thomas to Porto Rico, which is in working order. The contractors thence proceeded with the cable from Porto Rico towards Jamaica, but the cable was again broken when within 20 miles of Morant Point, and is not yet recovered. They then proceeded to lay the cable from St. Thomas to St. Kitt's, and the system is now complete through the various islands of Antigua, Guadaloupe, Dominica, Martinique, St. Lucia, St. Vincent, Barbadoes, Grenada, Trinidad, and thence to Georgetown, Demerara, whence the land line is completed to Berbice. The land line in Trinidad is also in working order, and the one in Guadaloupe is almost complete. The directors add that the difficulty in which they are placed, owing to the present incomplete state of the company's system, is enhanced by the fact that it accidentally came to their knowledge in April last that Sir Charles Bright, whose services as engineer of this company they had thought themselves fortunate in securing, had accepted the position of sub-contractor for the laying of the cable. Upon this they acquainted that gentleman of their having been advised that his office as engineer became vacant from the date of the sub-contract, and they have secured the services of Rear-Admiral Hugh Dunlop, C.B., to act as Commissioner to the West Indies to inquire into the causes of delay.

FIG. 3.

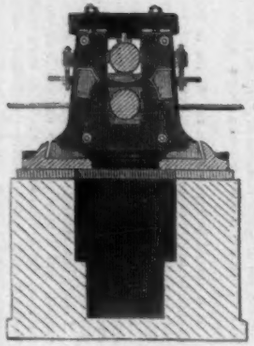
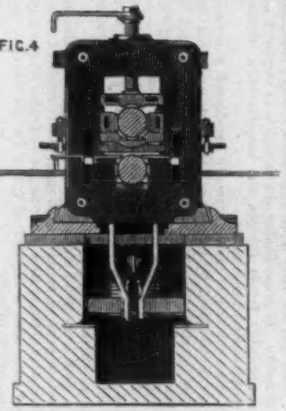


FIG. 4.



A Bisulphide of Carbon Engine.—A Boston correspondent of the *American Artisan* thus gives his experience in utilising the waste heat from a boiler of a steam engine: "I am running a 20 horse engine constantly with the heat obtained from exhaust steam of another 20 horse engine, thereby doubling the amount of power previously produced by the consumption of a pound of coal. This can be done with any engine now in use. The apparatus used for the engine I am now running consists of a tubular boiler, 26 in. in diameter, and 10 ft. long, with 60 1¼-in. iron tubes in it. This boiler is placed in an upright position, and filled half-full with the bisulphide of carbon, and is heated by passing the exhaust steam through the tubes. It enters the top of the boiler and passes out at the bottom; the steam is completely condensed in passing through; and the temperature of the water of condensation discharged at the bottom of the boiler does not exceed 120° Fahr. at any time. The latent heat of the steam is absorbed by the bisulphide of carbon, which is converted into vapour very rapidly under a pressure of 50 lb. to the inch. This vapour I use to drive my second engine, and find the supply ample to do as much work as the engine whose exhaust is used is doing. The exhaust from the engine using the bisulphide vapour is condensed by passing through a coil of iron pipe immersed in water, and is pumped back into the bottom of the boiler as fast as condensed, and used continuously, the waste not exceeding half a gallon per day. Only 40 gallons are required to work the engine successfully."

NOTES FROM PARIS.

PARIS, Nov. 12, 1871.

NARROW GAUGE RAILWAYS.

ALTHOUGH the narrow gauge railway question has been little studied in France, it has, nevertheless, been the subject of frequent discussion. Our technical Journals have devoted many articles to point out the advantages of the system, and interesting discourses have taken place on the subject at the Société des Ingénieurs Civils. The light traffic, which lines remaining to be made in this country can hope to obtain, but the construction of which is demanded in many districts, leads forcibly to a consideration of the most economical means of constructing and working, although the administrative weakness, and the ill-placed ambition of the local authorities, would wish to place on exactly the same footing the smallest line of local interest, and the greatest thoroughfare for international traffic.

M. L. Dagail, C.E., has just reviewed in a pamphlet the various arguments presented in favour of narrow gauge lines, and the objections offered to them. The following is a *résumé* of the conclusion of his work.

There are in France a great number of railways still to be made. The most economical lines hitherto constructed in the country have cost from 5120*l.* to 7600*l.* per mile, and produce net receipts of from 500*l.* to 650*l.* per mile per annum.

It will be very difficult to find similar traffic for the lines yet to be built, on which the business to be done will probably not exceed much more than half this amount. It is important to fix at the following conditions to establish railways for existing traffic, in such a manner that they may prove productive. It is necessary to refrain from granting subventions too freely if we wish to aim at a real reduction of tariffs. In proportioning the capital to be employed to the probably future receipts, the adoption of a narrow gauge is almost a necessity.

This solution is to-day generally considered a correct one, is sanctioned by experience, and is recommended by men the most competent to form an opinion in France, in Germany, and in England. Break of gauge is not a serious objection in the adoption of narrow gauge lines.

Narrow gauge railways are so economical that they can be constructed for the accommodation of a traffic of 200*l.* or 300*l.* per mile, according to whether the company does or does not receive a subvention.

Such lines afford every advantage for small traffic, as well in point of security as in speed and in capacity. The adoption of the system would secure to France an economy of more than a milliard of francs for the railways remaining to be built.

If for light traffic the construction of the broader gauges and the use of heavy material is persisted in, the companies will be ruined, whilst narrow gauges will insure their prosperity.

If it should be necessary in the future to increase the gauge, the money economised and capitalised, and the surplus receipts obtained, would at the end of 25 years amount to a sum double that required for the widening.

It is advisable that the administration of public works should not always run in the same groove, but should adopt economical improvements, and should enlighten the population as to the advantages of narrow gauge lines.

I share the opinions expressed by M. Dagail on this subject, and I may quote an extract from an article I wrote on the system in 1869: "The word 'railway' has to-day a most comprehensive signification, embracing all classes, from the grand line, defeating with numerous and important works of construction, the irregularities of the ground; traversing, at all cost, the most costly and difficult country; and erecting monumental stations in cities: to modest roads from 18 in. to 3 ft. 3 in. wide, running along the established roads, the contour of which it follows, with sheds for stations and a rudimentary rolling stock; from lines costing 50,000*l.* a mile, to others built for 2500*l.* Does it not seem that this great variety constitutes in itself the true solution of the difficulties which the establishment of lines of local interest present? Where the scantiness of the probable traffic, or the parsimony of subventions do not permit of the construction of a railway of broad gauge with rails of ordinary weight, able to receive the rolling stock of main lines to which they are near, it is necessary to be contented with a line of smaller capacity, with light rails, and established on the existing roads; such lines will offer, over the ordinary routes marked, advantages in economy of transport, and will permit the creation of a profitable enterprise without much sacrifice, whilst the construction of a great line would cost the State, the Departments, the Commune far more, and would only create an enterprise bound for ruin from the first day of its inception."

The consideration seems of still more importance to-day when France, to return to her prosperity, should follow the laws of strict economy in developing her elements of production.

UTILISATION OF WHEAT.

During the month of August, 1871, M. Sézille described before the Agricultural Society of France, a new process of purification of wheat. A commission, numbering nine members, charged to examine this process, has just addressed to the society a report, of which the following are the principal points.

M. Sézille presents a project of purification without grinding. The wheat is submitted simply to a process of decortication. The advantages sought are—the economy due to the suppression of the cost of grinding and the utilisation for food of the whole of the alimentary substances contained in the wheat. The first operation is to submit the grain to a process of decortication in a special apparatus, which takes from the wheat in films all the woody part which forms the skin of the grain, about 5 per cent. in weight. The wheat thus decorticated is soaked in water until it has absorbed half its own weight. In this state it is passed between two cylinders, which crush it, and form of it a homogeneous paste; to this paste is then added a proportion of yeast, in order to give to the bread its ordinary aspect.

M. Sézille sent two samples of bread prepared on a small scale by this process. They were well raised, and rather compact, of agreeable taste and smell, and they were preserved for eight days without any alteration, in a moist room.

It has not been possible for the commission to follow the process experimentally, but theoretically they admit that the proposed process ought to give out of 100 lb. of wheat 95 lb. of bread, containing an average of 19 per cent. of oxygen, 2 per cent. of fatty matter, and 2.5 per cent. of mineral substances, whilst by grinding only 75 lb. of bread was obtained, containing only 10 to 11 per cent. of oxygen, 1.2 to 1.4 per cent. of fatty matter, and 1 per cent. of mineral substances. Thus, then, in brief, out of 100 lb. of wheat 20 lb. more of bread are obtained, representing an increase of some 25 per cent. of the nutritive value.

The commission concluded by saying that the process of M. Sézille offers theoretically great advantages, and that it would be of much interest to test practically the efficiency of the system, and that this end could be best achieved by obtaining from the Ministers of War, of Marine, and of Commerce, and from the administration of the city of Paris, permission to test the result in one of their establishments.

We do not know if there will be anything made out of this process, which is almost copied from the Arabs, but we are struck with the singular conclusion of the commission who can think of no better idea than to invoke the aid of the administration to obtain a trial. It is not thus that one obtains in England the trials of an invention of general interest.

ACADEMY OF SCIENCES.

M. Ad. Jacot has presented a paper to the Academy of Sciences upon the industrial working of a bed of chloride of potassium, at Kalatz, in Galicia. There was discovered two years since a bed of sylvine, which has the same qualities as "Stassfürth." Afterwards kainite in greater quantities than the sylvine, and forming two distinct beds. They gave the following analysis:

Sulphate of magnesium	30.04
Chloride of potassium	29.46
Chloride of sodium	20.67
Chloride of calcium	1.27
	81.44

The workings yield about 85 tons per day. The mineral is broken and ground, dissolved in warm water, and crystallised. The chloride of sodium and of potassium are obtained separately, and in a pure state. The latter is dried and placed in sacks, and is sold to the chemical factories of Vienna.

ANALYSIS OF NITRO-GLYCERINE GASES.

M. L'Hôte explains in an essay how he has succeeded in analysing the gases produced from the explosion of nitro-glycerine. He combines eudiometres of Mitscherlich (black oxids of copper) with organic analysis tubes of green glass. He introduces into the apparatus 10 cube centimetres of gas produced from the decomposition of water by electricity. The nitro-glycerine is introduced by the aid of a capillary pipette in little globules of thin glass containing from 5 to 6 milligrammes of the matter. An electric spark is then passed through the apparatus. The explosion of the gaseous mixture breaks the globules, and explodes the nitro-glycerine.

The gas obtained is colourless, and contains a proportion of bioxide of nitrogen. This gas, submitted for analysis to the successive action of absorbents, leaves a residuum of pure nitrogen. It is found that 1 gramme of nitro-glycerine gives 284 cube centimetres of gas, at an equivalent temperature of 0 deg. centimetre, and a pressure of 29½ in. of mercury. One hundred parts of the gas in volume contain:

Carbonic acid	45.72
Bioxide of nitrogen	20.36
Nitrogen	33.92
	100.00

PHOSPHATE OF LIME.

M. Dumas has exhibited before the Academy some samples of natural phosphate of lime, coming from Cayeaux, in the neighbourhood of Montauban, and of Cayarc in the Department of Lot, where the material has only recently been excavated, but in which it has developed into a considerable industry. The deposits were discovered several years ago by M. Poumarède, and samples were sent to the School of Mines. The analysis showed that they contained 32.62 per cent. of phosphoric acid. The environs of Cayeaux and Cayarc belong to the mean colitic period, and form plateaux at a mean height of about 1100 ft. The phosphate of lime belongs to one of those varieties deprived of crystallisation, and called phosphorite to distinguish it from the apatite, which is crystallised. For the most part it is whitish, but sometimes coloured grey, yellow, or red; it shows frequently a very characteristic concreted structure.

France possesses, in several departments in the north and east, numerous beds of phosphate of lime. The working has not as yet been conducted on a large scale, and the production of phosphate is far from having acquired the importance that it has gained in England. However, attention has been called to the enterprise for some years, and the discoveries with which the Academy has been made acquainted, will not fail to stimulate the working of these valuable sources of mineral manure.

DYNAMITE.

We find in a recent bulletin of the Academy a note on dynamite, but the readers of ENGINEERING have already been made acquainted with all concerning this explosive; we need, therefore, extract from this note only a few of the most recent facts.

The manufactory of Paulille produces about 35,000 lb. of dynamite a month. Established in November, 1870, it has furnished already some 220,000 lb. The total production of M. Nobel exceeds to-day 4,400,000 lb. In working mines, making tunnels, and submarine works in France, Spain, and Italy, and in Africa, the dynamite finds its chief market. Its great rapidity of action, and its property of exploding under water, render it particularly valuable in destroying very hard or fissured rocks in watery strata. The tunnel of St. Xist, on the line in course of construction between Montpellier and Rhoden, is being pierced in the Jurassic limestone by five vertical shafts and the two ends. The rock is hard, but the large quantity of water retards principally the work of the mines. The rate of advance with dynamite is 11½ in. in the shafts, and 4 ft. 3 in. in the galleries, as compared with $\frac{7}{12}$ in. in the shafts, and 11½ in. in the galleries, obtained with powder.

In the open cuttings and tunnels of Cerbere, on the Port Vendres section on the Spanish frontier, works which had been impossible at the contract price without the use of dynamite, are being profitably carried out, now that its employment is permitted.

FRENCH EXHIBITS AT THE RECENT EXHIBITION.

Most of our readers have been able to visit the French section of the International Exhibition recently closed. Although it was tardily opened, on account of the difficulties resulting from the war, and although many French merchants and manufacturers were prevented from contributing, it offered, however, many points worthy of examination.

The report of MM. Ozenne and du Sommerard, the General Commissioners of the Exhibition, brings out these points, and we may extract some particulars worthy of notice.

Although it is impossible to value directly all the results obtained, and though some of them may easily escape notice, the Commissioners have been able, by exact estimation, to prove the success of the French annexe, and to arrive at the result that may be expected in the future.

They established in the section a special office intended to furnish to visitors all information on the value of the objects exhibited. This bureau, which was of course a gratuitous affair, sold a large number of the works of French artists. Thanks to this organisation the following results were obtained: In the industrial arts, the value of articles sold was over 20,000*l.*, and the orders exceeded 40,000*l.*; for works of art the figure reached 5000*l.* From this result several French houses have decided to establish in London branch establishments.

It is easy to see that this result would prove a powerful stimulant to artists and manufacturers who wish to exhibit during 1872, and already the elements for the ensuing year are coming together.

In giving to the fine arts, to the industrial arts, to inventions, and to discoveries, the prominent place which so justly belongs to them, in assigning to them a principal and permanent place during the whole duration of the exhibition, and in grouping around this essential part each year a certain number of industries in such a way that they can all be passed in review during the five years, England has devised a new kind of exhibition which will develop international relations, and which will not lack of abundant success.

ENGINEERING SOCIETY, KING'S COLLEGE.—At a general meeting held Friday, November 10th (Mr. Hunter, president, in the chair), Mr. R. W. Baynes read a paper on the "Theory of the Microscope." He commenced by briefly noticing the arrangements of simple microscopes, going on to describe the compound microscope, enlarging at length upon the expedients adopted for counteracting "distortion," "spherical" and "chromatic" "aberration;" and then giving a few formulæ for determining the relation between the several lenses forming a microscope. The author then explained the method of adjusting "object" and "eye" pieces, and the cause of the necessity for using various powers in the pursuance of microscopic research. He concluded by describing special forms of instruments (such as the "solar" and the "binocular" microscopes) designed for particular branches of inquiry. The paper was illustrated by several first-class modern instruments and by numerous diagrams. In the discussion which followed, among others, Messrs. Brittle, Kirkby, Clough, Douglass, and Terry took part. A vote of thanks having been returned to Mr. Baynes for his able paper, the meeting then adjourned.

THE PNEUMATIC DESPATCH SYSTEM.

At the first meeting of the session of the Institution of Civil Engineers, 1871-72, Mr. Charles B. Vignoles in the chair, a paper on "Pneumatic Despatch Tubes—the circuit system," of which the following is an abstract, was read by Mr. Carl Siemens, M. Inst. C.E., and was afterwards discussed.

The author commenced by remarking that, soon after the introduction of the electric telegraph, it was found necessary, in large towns, to establish branch telegraph stations, at which messages could be collected, for, and to which messages, could be sent from, the central station. Both telegraph wires and messengers were tried for the purpose of keeping up communication between the central and branch stations; but neither of these means was found perfectly satisfactory, as the messengers proved too slow, and re-telegraphing the messages added another chance to their being mutilated in transmission. Under these circumstances, the Electrical and International Telegraph Company connected their central station in Telegraph-street, and their nearest branch stations in the City, by means of pneumatic tubes, through which carriers, containing messages, were forced in one direction by compressed air, and in the other by the air of the atmosphere flowing through the tubes into an exhaustive receiver. This system of tubes, which was designed and carried out by Mr. Latimer Clark, M. Inst. C.E., and Mr. Varley, M. Inst. C.E., was still in existence, and had indeed been considerably extended since the telegraphs had passed into the hands of the Post Office authorities. It was worked by means of air-pumps, actuated by steam engines placed in the basement of the central station. This system had comparatively a very limited power of despatching messages, except for short lengths, as it was necessary to wait till a carrier had completed the whole of its journey in one direction, before another could be sent in the other direction, and it did not admit of intermediate stations being inserted, but every two stations must be connected by means of a separate tube.

In April, 1865, the Prussian Government applied to Messrs. Siemens and Halske, of Berlin, to propose a system of pneumatic tubes for that city. After making numerous experiments, that firm proposed laying tubes, arranged in a circuit, to be traversed by a continuous current of air always kept flowing in the same direction. The peculiarities of this system, namely, the continuous current of air and the power of putting carriers into the tubes at any point, gave it great superiority over previous systems in the amount of work it was capable of doing. The Central Telegraph Station and the Exchange at Berlin were connected together, on Messrs. Siemens and Halske's system, in 1865, by means of two parallel lines of drawn wrought-iron tubing, 2¼ in. internal diameter, one tube being used exclusively for the passage of carriers in one direction, and the other for carriers going in the opposite direction. The continuous current of air was produced by means of a steam engine, working a double-acting air-pump, in the basement of the telegraph station. After the first line had been in use in Berlin for a year and a half, and had proved perfectly satisfactory, the Prussian Government ordered an extension from the Telegraph Station to the Potsdamer Thor, with an intermediate station at the Brandenburger Thor, and expressed the intention of providing the whole of Berlin at a future time with a network of pneumatic tubes. The total length of the pneumatic lines laid in Berlin was 32,000 ft., including the first experimental line of 5670 ft. On account of the great length of the second circuit of tubes, they were made 3 in. in diameter inside, and this dimension would be adhered to in future extensions.

There was also a circular pneumatic system in Paris, but the continuous current of air was not used. Messrs. Siemens and Halske recommended their plan to the French Government before the Berlin line was constructed; but the French Government preferred a modified arrangement of their own. Each station, on the French line, was provided with large air-tight vessels, which were in communication with the water-mains of the town. By admitting water under a considerable pressure, the air in the vessels could be compressed to about two-thirds of its volume, and by means of the air so compressed, the carrier, or train of carriers, was driven to the next station, from whence it was again driven to a further station, by the air which had been compressed in another set of vessels, and so on, from one station to another, at stated times, round the circuit. The author observed, that the consumption of water by this system must be enormous, because as the air was compressed to two-thirds of its ordinary volume, for every volume of air used, the expenditure of a volume and a half of water was required. The French line was circular, in so far as it started from the Central Telegraph Station, and passed through four stations, namely: at the Madeleine, the Grand Hôtel, the Bourse, and the Post Office, and returned to the Central Telegraph Station; so that the carriers were always sent through the tubes in the same direction. The working powers of this system were of course very limited.

In London, there was another pneumatic line which should be mentioned, although not designed for the conveyance of telegrams or single letters, but of large parcels; namely, the large cast-iron tube, of a D-section, running from Euston Station, *viâ* Holborn, to the General Post Office.*

Five or six years ago, Messrs. Siemens Brothers tried to induce the Post Office authorities to adopt their system of pneumatic tubes for the conveyance of letters in London; but it was only in December, 1869, when the telegraph lines were being taken over by the Government, that they received an order to lay an experimental circuit between the Central Telegraph Station and the General Post Office in St. Martin's-le-Grand. This line was completed and opened for traffic in February, 1870, and, after half a year's work, the great advantages of the system having shown themselves, a further length to Fleet-street, and subsequently to the West Strand Office at Charing-cross, was decided upon. The different stations were connected by two lines of wrought-iron tubing, having an internal diameter 3 in.; both lines were laid in the same trench, at a depth of about 12 in. below the pavement, and parallel to one another. The tubes forming the circuit were of an average length of 18 ft. 8 in. For turning round street corners, and for rising and falling in the different buildings, pieces bent to a radius of 12 ft. were used. The ends of every two consecutive tubes were brought close together, and joined by means of a cast-iron "double-collar," similar to those used for joining cast-iron water-pipes, but having in the centre of its length an annular projection 2 in. wide, which was bored out just to fit over the ends of the tubes to make them butt true. A common lead and yarn joint was made at each end of the collar. Water-traps, communicating by means of slots with the bottom of the tubes, were placed at depressions on the line, to enable water, which might have got into the tubes through condensation or otherwise, as well as dust, or foreign matter, to be drawn off, without its being necessary to take up any of the tubes. A current of air was kept constantly circulating through the tubes, by means of a steam-engine and double acting air-pump, supplied by Messrs. Easton, Amos, and Anderson, placed in the basement of the Central Telegraph Station. Each station on the circuit had two sending and receiving instruments, one on the up and another on the down line of tubes. The instruments consisted of two short tubes, fixed side by side in a rocking frame, each of which could be brought into line with the circuit of tubes, at the pleasure of the attendant. Each end of the rocking frame was faced and worked against the faced side of a boss, into the centre of which was fixed a piece of wrought-iron tube, forming part of the circuit. Three annular grooves were turned in the faced side of the boss round the tube forming the end of the circuit. The use of these grooves was to prevent the escape of air between the ends of the rocking frame and the bosses at either side of the apparatus. One of the tubes in the rocking frame, that called the sending or "through" tube, was simply a hollow cylinder, of the same internal diameter as the tubes forming the circuit. When this tube was in line with the main tubes, a carrier could pass through the instrument without being stopped, and this tube was used when it was desired to put carriers into the circuit. The other, or receiving tube, had a perforated diaphragm at its "down-stream" end, so as to arrest the carriers when it was placed in line with the main tubes of the circuit. This tube was D shaped in section, with a flat cover, which could be taken off if required; as for instance, to remove carriers, should two arrive at once, and so prevent the rocking frame being moved. The flat cover of the receiving tube was furnished with a pane of glass, to enable the attendant to see when a carrier had arrived. To prevent the continuous flow of air in the whole system of tubes from being impeded, should the receiving tube be left in circuit after it had caught a carrier, there was a by-pass, which communicated with the tubes of the circuit on both sides of the instrument. A sliding rod, held on suitable supports, was supplied for pushing the carriers out of the receiving tube when intercepted and brought out of the circuit. The manipulation for sending and receiving carriers was exceedingly simple; and a treadle was provided to enable the attendant to move the rocking frame with his foot. The carriers for the reception of telegrams, letters, &c., consisted of small cylinders made of gutta-percha, papier maché, or tin, covered with felt, drugget, or leather. It was found, in practice, that the carriers need not fit the tubes at all accurately. Mr. Culley, M. Inst. C.E., chief engineer of the Post Office Telegraphs, had adopted the block system, such as was used on railways, for working the tubes, and he employed instruments introduced by Mr. Tyer, Assoc. Inst. C.E., for making the signals. The use of the block system prevented the tubes being able to develop their full working powers, which would be obtained by sending carriers one after another at half-minute or shorter intervals—a mode of working that could be easily carried out with a constant current of air, as was the case when the circular system was worked independently of other systems, which was not yet the practice in the metropolis. The total length of line now working in London, from Telegraph-street to the West Strand Office and back, was 6·90 yards, as follows:—From the instrument room, on the third floor of the Central Telegraph Station to the General Post Office, 852 yards; from the General Post Office to the Fleet-street Office, 1206 yards; and from the Fleet-street Office to the West Strand Office, near Charing-cross, 1387 yards.

The following results as to speed were obtained during experiments made with the two sections first opened. The mean pressure during those experiments was 7 lb. per square inch at one end of the circuit, and the vacuum at the other end of the circuit was 11 in. of mercury; under these conditions, the circuit being worked with both pressure and vacuum, the times were:

	yards	m.	s.
Telegraph-street to General Post Office ...	852	1	54
General Post Office to Temple Bar	1206	2	28
Temple Bar to General Post Office	1206	2	10
General Post Office to Telegraph-street ...	852	1	13
Totals	4166	7	45

These experiments proved that the speed of the carrier was much greater as it approached the vacuum end of the tube than it was at the other end.

The necessity of having a steam engine with air pumps and reservoirs was a great hindrance to the general introduction of pneumatic tubes; but this inconvenience had been successfully removed by the construction of an exhausting apparatus, working by the direct action of steam upon a current of air. In this exhausting apparatus the steam from a boiler was made to issue, in the form of a hollow cylinder, from an annular nozzle placed in the centre of the apparatus, the opening having a width of about one millimetre all round. The steam issuing in this form had the greatest possible surface, both inside and out, for contact with the air in the apparatus, which air was in connexion with, and was drawn from, the pneumatic tubes. With one of these exhausters, a vacuum equal to a column of 23 in. of mercury was obtained, with a less expenditure of steam than would be required to work a steam engine and pump to effect the same object. The principal recommendation of the steam exhauster, besides its extreme simplicity and the small space it occupied, was its cheapness of construction, as the cost only amounted to about one-twentieth part of an engine and pumps.

Where so large a traffic was not expected as in London, the tubes, instead of being laid side by side in the same trench, could, at a trifling additional cost, be laid in a large circuit, and so be made to include many more intermediate stations, each station in that case having only one sending and receiving instrument.

Experiments made at Berlin proved that, in very long lines of tubes of small diameter, a sufficient velocity of the column of air could be obtained with the pressure at the two ends differing within quite practical limits. If the carrier was made so as to move with very little friction, its speed would be nearly equal to that of the air by itself. The momentum of the carrier and that of the column of air might be entirely disregarded, as both were infinitely small when compared with the prevailing friction of the air in the tube. As under equal conditions of pressure at the two ends the speed in the tube increased as the square root of the diameter, and decreased as the square root of the length of the tube, the length of a pneumatic system might be extended with similar results as to speed, in the same proportion as the diameter of the tubes could be increased; that was, the same speed as was obtained through a tube of a certain diameter and length, might be obtained through another of double the length and double the diameter, the difference of the pressures at the two ends of the tubes remaining identical.

Up to the present time, as far as the public was concerned, the pneumatic tubes in London, Berlin, and Paris had only been used for the conveyance of telegraphic messages; but the British Post Office authorities had already considered the question, whether it would not be advantageous to have the letter-post service in London executed by means of pneumatic tubes. With such a system of distribution an accumulation of letters at principal offices would be entirely avoided.

* Fuller information with respect to this line will be found in a paper read before the British Association in 1870, by Robert Sabine, Assoc. Inst. C.E., *vide* ENGINEERING, September 23, 1870.

RIVER STEAM LAUNCHES.

To the Editor of Engineering.

Sir,—I read the description in your journal of November 3rd, of the celebrated Miranda, whose almost fabulous speed is well known in the upper reaches of the Thames, and perhaps—though extreme speed is not the purport of this note—some of your readers may be surprised to know that I have lately had a twin screw boat built on a novel design. She is 40 ft. long 7 ft. beam, draws 9 in. water forward and 18 in. aft, when running in full trim, carrying comfortably from 20 to 30 persons, and a ton of coal sufficient for a week's work, 10 hours a day. Her speed with 90 lb. of steam is nine miles an hour, the twin screws are each three bladed 21 in. diameter, and are driven by two small (very small) cylinder independent engines. The boiler with the pendulous tubes, which I have found to be a first-class one for small boats, makes and holds steam rapidly and well, gives no trouble, and moreover never primes.

The boat was constructed on one great idea, that a light draught twin screw boat might prove a success, and this has so turned out. The parties who have purchased her are loud in their praises, and her efficiency is greatly enhanced by the great economy in working and the moderate price of 260*l.* for which she was built. Her great merit is that she can steam freely in parts of the river where other screws cannot move; she can be run ashore and backed off easily.

The boat, engines, and boilers are all of the best, and reflect great credit on the designer, Mr. Chaplin.

I am, Sir, yours truly,

Angelo Sedley.

38, Conduit-street, W., November 10, 1871.

MORRISON'S DOOR LOCK.

To the Editor of Engineering.

Sir,—Though agreeing entirely with your editorial note to a letter signed "A. B.," in your paper of last week on my railway carriage lock and fastening, I should feel obliged by your inserting a few remarks from my side in the next number of your esteemed journal. Without referring again to "A. B.'s" notion of the weakness of my lock—for no better reply could be given than you have made already—I will only call his attention to the small diameter of the pins of the hinges for carriage doors; these pins have to sustain a much greater strain than my fastening, and with an experience of 30 years I have never seen one of these pins broken. With respect to the second objection pointed out by "A. B," I will only state that there is no need of being afraid of the door requiring too nice an adjustment; all practical coach makers know that carriage doors become always too large and have to be eased, a circumstance decidedly in favour of my lock, for when once fitted to the striking plate, the door can never be shut without being securely fastened.

After your remarks on the arrangement which "A. B." has been good enough to propose instead of my construction, I have nothing further to say, but to apologise for intruding on the valuable space of your paper.

I am, Sir, your obedient Servant,

James Morrison, Coach-maker.

13, Chatsworth-road, Stratford, November 15, 1871.

Telegraphy in the East.—The submersion has been commenced of a cable which is to connect Cyprus with Syria. The new line will be shortly in working order.

SIEMENS'S REGENERATIVE GAS FURNACES AT THE BRITANNIA WORKS, MIDDLESBROUGH.

(*For Description, see opposite Page.*)

FIG. 1

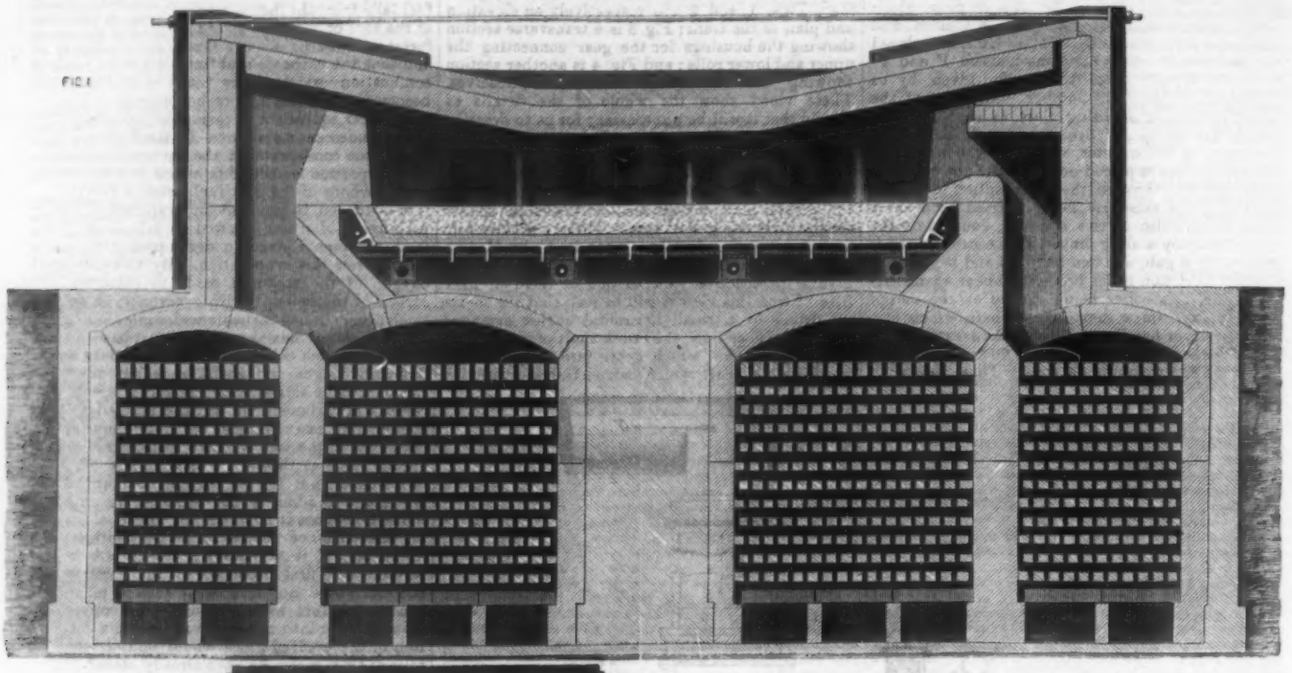


FIG. 2.

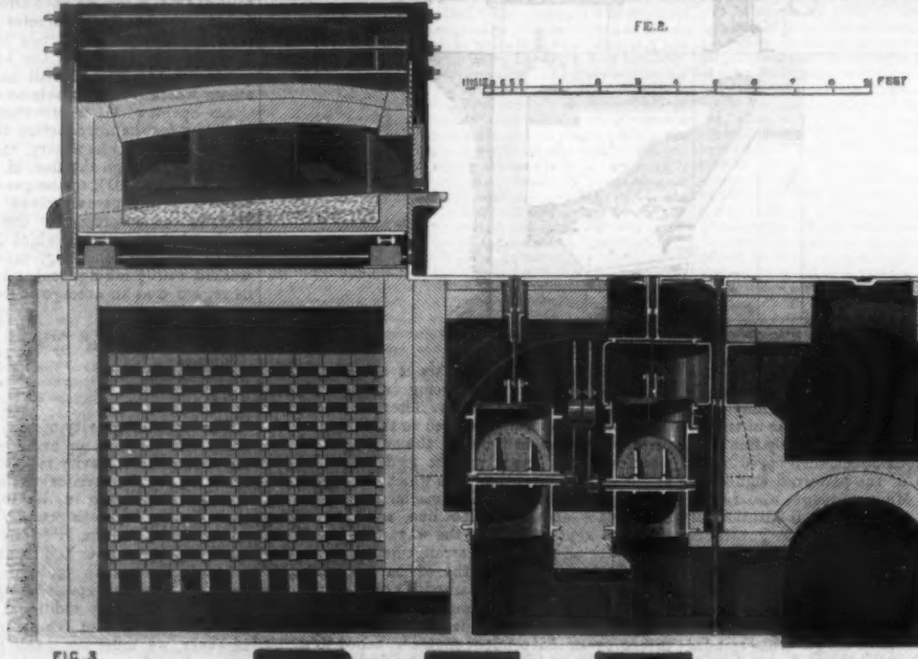
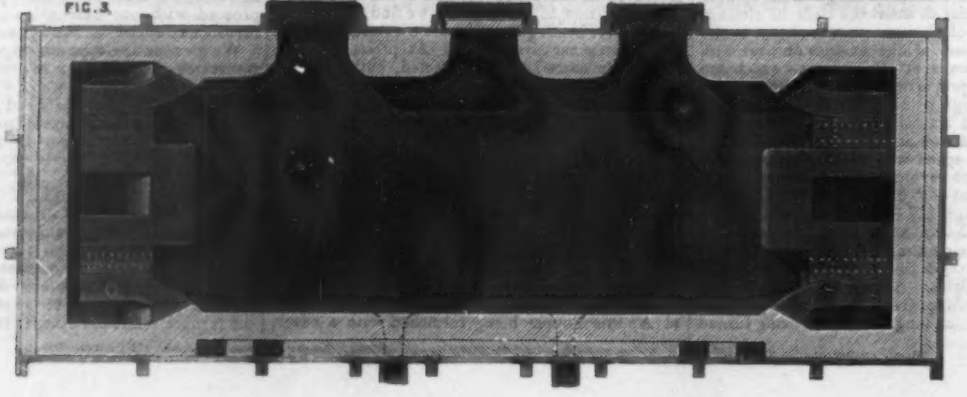


FIG. 3.



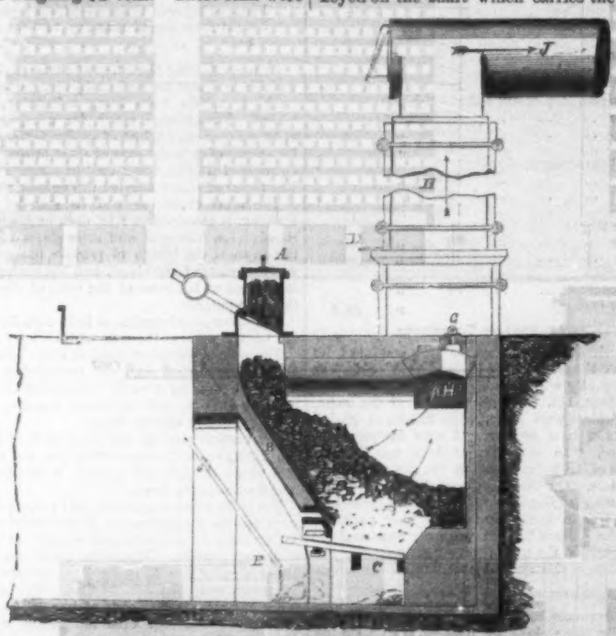
THE BRITANNIA WORKS.

(*Continued from page 300*)

THERE are, as we have said, two complete forge trains at the Britannia Works, each driven by an independent engine. The two engines, which were made by Messrs. Martin Samuelson and Co., of the Albert Dock Works, Hull, are placed side by side in the positions marked F and F′ in the general plan of the works, given by us on page 298 of our last number. They are of the horizontal non-condensing class, as shown by the engravings on page 316, and each has a cylinder 36 in. in diameter, with a 4 ft. 6 in. stroke. The slide valve is placed on the top of the cylinder, and is worked through the intervention of a rocking shaft, the eccentric being carried by a short shaft, which also carries a crank, coupled to the main crank by a drag link. The eccentric rod is made with a gab, and can be lifted and kept out of gear by a friction roller brought to bear against its underside, this roller being carried at the end of an arm fixed on a short weigh-shaft, which also carries a lever handle provided with a catch plate. The fly-wheel of each engine is 20 ft. in diameter, and has a rim weighing 34 tons. These rims were each cast in a single piece, at Messrs. Head, Wrightson, and Co.'s works at Stockton, and were brought down to their destination by rail on a Sunday, at a time when the line was otherwise clear of traffic. The wheels are altogether a particularly fine job. The engines drive the rolls direct, their speed being regulated by governors of the pattern designed by Mr. Jeremiah Head, of Middlesbrough, who read a paper describing them before the Institution of Mechanical Engineers last July. In these governors —of the prompt action of which we have before had occasion to speak highly—the arms are crossed so that the points of suspension are situated on the opposite sides of the spindle to the balls to which they respectively belong, while a spring is interposed between a fixed collar on the governor spindle and the sliding collar to assist the balls in closing. The arrangement of this governor is shown in the side elevation of one of the engines on page 316. The remaining details of the engines—which are well and strongly proportioned—will be understood from the engravings without further description. In July last, when we visited the works the forge trains were being driven at about 55 revolutions per minute; but this speed was, we understood, to be reduced to about 45 revolutions per minute.

The forge trains—of one of which we publish engravings on page 317—were constructed by Messrs. Claridge, North, and Co., of Bilston, a firm well known for their rolling mills for all classes of work, from wire and thinnest sheets up to the heaviest armour plates. As will be seen from our illustrations, each forge train consists of four pairs of rolls, each 6 ft. 6 in. long, these rolls being turned for rolling the various sizes of puddled bars required to form piles for the finishing mills. Each train of rolls is driven by its engine without the intervention of gearing, the lower rolls being coupled direct to the crank shaft. In our engravings, Figs. 1 and 2 are respectively an elevation and plan of the train; Fig. 3 is a transverse section showing the housings for the gear connecting the upper and lower rolls; and Fig. 4 is another section showing the housings for the rolls themselves. These views show the whole of the details so clearly that it will be unnecessary for us to describe them further. We may remark, however, that the proportions are excellent throughout.

At a short distance from the forge trains and in front of them—in the positions marked I and I′, in the general plan on page 298—are placed the scissor shears for cutting hot bars. These shears, which are of a very handy form, were made by Messrs. Thwaites, Carbutt, and Co., of Bradford, and we give a perspective view of one of them on page 316. From this view it will be seen that the shears are driven by a small horizontal engine arranged below the floor line, the crank shaft of this engine carrying a pinion which gears into a spur wheel keyed on the shaft which carries the eccentric by which the lever of the shears is actuated. The lever is of a T-form, there being two sets of jaws which of course cut alternately. The main framing of the machine is firmly secured to the engine bedplate by wedges and bolts; the outer end of the machine is supported by cross girders which span at the ground level the pit in which the engine and gearing are contained. The machine occupies very little space above the floor line, and the working parts are kept well out of the way. The shears are fitted with an adjustable arrangement for measuring off the various lengths of bars requiring to be cut. At the point marked K, on the plan, is placed a shearing machine for cutting cold iron, scrap, &c. This machine is of an ordinary pattern driven by an independent engine attached to it.



Passing now to the rail mill we find that all the furnaces for heating the piles are constructed on the Siemens regenerative system. At present, twelve of these furnaces have been erected, but ultimately the number is to be increased to sixteen. Gas is supplied to the furnaces by thirty-two gas producers arranged in eight groups of four each as shown at L, in the general plan, on page 298. Both the gas producers and furnaces have been constructed on Mr. Siemens's latest plans, and therefore—notwithstanding that the Siemens furnace has been frequently described in our pages—it will be advisable that we should give a brief account of them here. From the section of one of the gas producers which we give on the present page, it will be seen that the fuel from which the supply of gas is to be obtained is introduced into a kind of hopper at A, this hopper being furnished with a cover, and having, moreover, a drop bottom kept closed by a lever and balance weight. By lowering this bottom after the cover has been placed on the hopper the contents of the latter can be discharged into the producer without risk of admitting air. The fuel falls from the hopper on an inclined plane, B, at the foot of which is the fire-grate, C. The fuel forms, as will be seen, a thick bed on this grate, and thus the carbonic acid formed by the complete combustion which takes place next the grate becomes converted into carbonic oxide by taking up another equivalent of carbon as it passes through the incandescent mass above. Of the heat generated during the combustion of the carbon into carbonic oxide a portion is utilised in vaporising the tar and hydrocarbons of the raw fuel, while a further portion is turned to account in evaporating a small proportion of water allowed to fall in the ashpit from the pipe E, and in decomposing the steam arising from this evaporation. By this process the oxygen of the steam is made to unite with the carbon of the fuel, producing carbonic oxide and a small proportion of carbonic acid, while the hydrogen becomes simply mixed with the other gases evolved. Altogether each cubic foot of steam gives a cubic foot of hydrogen and about an equal quantity of carbonic oxide mixed with the small variable percentage of carbonic acid already alluded to. The combustible gases obtained by the decomposition of the steam in the way we have just described are of special value as they are free from any admixture of nitrogen; but the proportion of steam which it is possible to admit to the producer in practice is limited on account of its cooling effect. This cooling effect has, of course, to be kept within proper limits, as, if it was allowed to go too far, the carbonic acid first produced by the combustion of the fuel would not meet with such a mass of incandescent fuel as is required to convert this carbonic acid into carbonic oxide, and a deterioration of the evolved gases would be the result. It follows from what we have already stated that the less bituminous the character of the fuel and the less, therefore, the proportion of constituents which have to be volatilised by the heat generated in the producer, the greater will be the proportion of steam which it is allowable to admit and *vice versâ*.

An opening, G, is provided in the top of the producer for the introduction of a bar for breaking up the fuel when necessary, and the gases evolved are led off through the flue, H, (which is furnished with a damper, D), to the gas tube, J. The composition of the gases evolved of course varies to some extent according to the description of fuel used and the manner in which the producer is managed; but the following, taken from a producer worked with ¾ caking coal and ¼ non-caking, may be regarded as an average analysis.

Carbonic oxide	24.2	} = 34.6	{ combustible gases.
Hydrogen	8.2		
Carburetted hydrogen ...	2.2		
Nitrogen	61.2	} = 65.4	{ incombustible gases.
Carbonic acid	4.2		
	100.0		

The specific gravity of this mixture of gases is about 0.78 (that of air being represented by unity) but this specific gravity is subsequently reduced to about 0.7 by the chemical changes which take place during the heating in the regenerators. During this heating a decomposition of the ammoniacal vapours and sulphuretted hydrogen takes place while the tar vapour and olefiant gas deposit carbon which is taken up by the water vapour and carbonic acid, the result being an increase in the volume of the gases additional to that produced by the mere increase of temperature. These points, however, we must not dwell upon here, but must proceed with our description of the regenerative furnaces as applied at the Britannia Works.

We give, on the opposite page, longitudinal and transverse sections and a sectional plan of one of these reheating furnaces which will show its arrangement. Each furnace has a bed 14 ft. 6 in. long by 6 ft. wide, there being three doors on one side for the insertion and withdrawal of the piles. The regenerators are arranged directly beneath the furnace as shown in the longitudinal and transverse sections, the length and total height in the centre of these regenerators being in all cases 7 ft. 3 in. and 8 ft. 6 in. respectively, while those for the air are 6 ft. 2 in. and those for gas 4 ft. 3 in. wide. In the longitudinal section one-half of the view (that on the left-hand side) is taken through one of the passages connecting one of the air regenerators with the furnace, while the other is taken through one of

the gas passages connecting the body of the furnace with one of the gas regenerators. Referring to this view and the corresponding transverse section and sectional plan it will be seen that the gas after leaving the regenerator enters the body of the furnace through two flues or openings about 3 ft. 6 in. apart from centre to centre, these openings being somewhat bell-mouthed as shown in the sectional plan. The air, on the other hand, passes from its regenerator through three vertical flues which lead into a broad but shallow inlet flue having an opening into the furnace 5 ft. 9 in. wide by 6 in. high. The air is discharged from this opening immediately under the furnace crown, and the gases thus form a partial shield between it and the iron which is being heated, and thus tend to protect the latter from the contact of free oxygen. The products of combustion pass off at the other end of the furnace through similar openings to those through which they were admitted, being led through one pair of regenerators to which they impart their heat. At certain intervals, as is well known, the direction of the currents is reversed, the pair of regenerators which had been heated by the escaping gases being employed to heat the incoming gas and air, while the other pair of regenerators are in their turn being heated by the escaping products of combustion.

The manner in which the supplies of gas and air are regulated is shown by the transverse section Fig. 2 on page 320, a view which also shows the reversing valves. Of the two flues shown on the right-hand side of this view, the upper is the gas-flue leading from the gas producers, and the lower a flue communicating with the chimney stack which serves for the whole group of furnaces as shown in the general plan of the works on page 298 of our last number. From the gas flue the gases pass into a cast-iron casing provided with a conical valve which can be raised or lowered by a screw and which is fitted to the mouth of a vertical descending pipe. This valve governs the supply of gas to the furnace, while an adjacent valve fitted to the mouth of another vertical pipe, as shown, controls the admission of air. From each of the vertical pipes just mentioned are led off laterally two branches, communicating with the two gas regenerators and two air regenerators respectively, and just at the point where these branches join the vertical pipes are placed the reversing valves. These valves are of the disc form, similar to common throttle valves, and when closed form an angle of about 45° with the axes of the pipes in which they are placed. When the reversing valves occupy the position shown in Fig. 2 the air and gas pass over the tops of the reversing valves and enter those branches which are removed by the plane of the section, while at the same time the two branches of which the mouths are seen just below the valves are placed in communication with the chimney flue. When the reversing valves are shifted, by means of the levers attached to their axes, so as to be inclined in the opposite direction, those branches which were previously receiving gas and air respectively are placed in communication with the chimney flue and *vice versâ*. The opening to the chimney flue is controlled by a sliding damper which can be raised or lowered by a screw as shown.

The advantages of the Siemens system of regenerative gas furnaces when applied as heating furnaces in iron works have been so frequently pointed out in our pages, and are, however, so generally acknowledged that it will be unnecessary to dwell upon them here. We need merely remark, therefore, that at the Britannia Works, the construction of these furnaces and their gas producers has been carried out in accordance with the teachings of the most recent experience, and that every care has been taken to adopt the arrangements best suited to the work to be done. The manner in which the furnaces are disposed two and two, with broad avenues between the alternate pairs, is shown by the general plan on page 298 of our last number.

(*To be continued.*)

RAILWAYS IN VICTORIA.—For the first time in the history of Victoria the manufacture of locomotives has been undertaken by local makers, as stated in last week's ENGINEERING. Tenders were recently called for the construction of ten engines relating to the North-Eastern Railway of Victoria and the competition was confined entirely to Victorian contractors. Six tenders were altogether sent in, three from Melbourne and three from Ballarat, the lowest being that of the Phœnix Foundry Company, Ballarat. The price was 2900*l.* per engine.

NOTES FROM GERMANY.

BERLIN, Nov. 13, 1871.

THE HODGSON WIRE TRAMWAYS.

AN Hungarian engineer, Mr. T. Bush, has made some improvements on the Hodgson system of wire tramways by employing two parallel cables instead of one. The modified system, it is said, possesses great advantages over the original one, especially with regard to the carrying of heavy loads, and the greater security of the ropes.

METAL FOR BEARINGS.

The following alloy has been found to give highly satisfactory results for plummer blocks, axles, brasses, &c. To 80 parts of melted copper are added 70 parts of antimony; the mixture is melted, and run out into thin plates. These are then remelted with tin in the proportion of 90 parts of tin to 10 parts of the copper and antimony, and run out again into thin plates. When used it is remelted, and run into the forms required. M. Volk, of Regensburgh, has employed an alloy for many years of which the following are the component parts: Copper, 5.6 per cent.; antimony, 11.2 per cent.; and tin, 83.2 per cent. He also employs the following mixtures to produce metals for various purposes:

For slide valves:		
Copper	81.9	per cent.
Tin	14.8	,,
Zinc	3.3	,,
	100.0	
or		
Copper	67.8	,,
Old brass tubes	22.0	,,
Tin	10.2	,,
For pump barrels, stop-cocks, and valve-boxes:		
Copper	87.7	per cent.
Zinc	10.7	,,
Tin	1.6	,,
For stuffing-boxes, valves, &c.:		
Copper	86.2	,,
Zinc	3.6	,,
Tin	10.3	,,
For eccentric rings:		
Copper	90	,,
Zinc	10	,,
For piston rings:		
Brass cuttings	94	,,
Copper cuttings	6	,,

COAST PROTECTION BY TORPEDOES.

Contact and electric torpedoes were both employed for the protection of the German coast during the war. The former had generally a charge of 82 lb. of powder, and were moored about 3 ft. below the surface of the water. The electric torpedoes were loaded with 220 lb. of dualin, equivalent to 1100 lb. of powder, and were fastened 8 ft. below the water. The explosion of these was brought about by means of batteries placed on the shore, and they were perfectly safe. On the other hand the contact torpedoes were exceedingly dangerous to handle, and three fatal accidents took place in lifting them from their positions. In addition to the defence torpedo attempts were made to project others beneath the hulls of the hostile vessels, but nothing resulted from this application.

DYNAMITE IN WELL SINKING.

In Denmark dynamite has recently found a novel application, namely, in the sinking of artesian wells. During the autumn of last year some persons sinking a well at Gjeddesdal struck upon a very hard bed at a depth of 75 ft., which they were quite unable to pierce. As there appeared no choice but to abandon the work, they ultimately determined to try the experiment of a charge of dynamite.

After the bore-hole had been cleared, a bottle containing about 2.2 lb. of dynamite was lowered. It was attached to two copper wires passed through the stopper of the bottle, and insulated by gutta-percha. When the charge was in position an electric spark brought about the explosion, with the result of a great concussion on the surface, and an upward discharge of the water which stood in the boring. The hole almost immediately filled with water, giving evidence that the obstruction had been removed, and the source of supply reached.

Two charges were afterwards fired in a similar manner, and the sudden rush of water left no doubt about the successful issue of the experiment.

TELEGRAPHY IN FRENCH RIVERS.—Workmen have taken up two telegraphic cables laid down in the Seine between Rouen and Paris, shortly before the siege of Paris, to enable the capital, if invested, to communicate with the provinces. The last portion of the wire between Conflans and Paris was completed two days since, and the cables have been sent to Toulon to be repaired.

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The following are the general dimensions of the structure:

	ft.	in.
Total distance, back wall to back wall of masonry	170	4½
Width of bridge seat on abutments	4	3
,, ,, pier	6	6
Distance centre to centre of end pins in one span, measured on the lower chord	82	6
Number of panels in each truss ... 6		
Length of each panel	13	9
Height of truss, centre to centre of chord pins	8	3
Distance between trusses, centre to centre	14	0
Height from top of masonry to base of rail	2	7

In proportioning the different parts of the structure the variable load was assumed at 1½ tons per foot lineal of each track, the middle truss being calculated for both tracks loaded. The ultimate strain for wrought iron was taken at 50 tons per square inch of section for tension, and 18 tons for compression in the case of short prisms, the well-known formulæ of Gordon being used in computation of columns. The factor of safety adopted throughout was six.

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The lower chord consists of links 7 in. deep, and of varying widths, upset at the ends with eyes for 4½ in. pins.

The main braces are formed of links having eyes at the ends for connecting pins, and arranged in sets, those sets which are required to resist compression as well as tension being bowed out, and connected together by rivets with distance ferrules between them.

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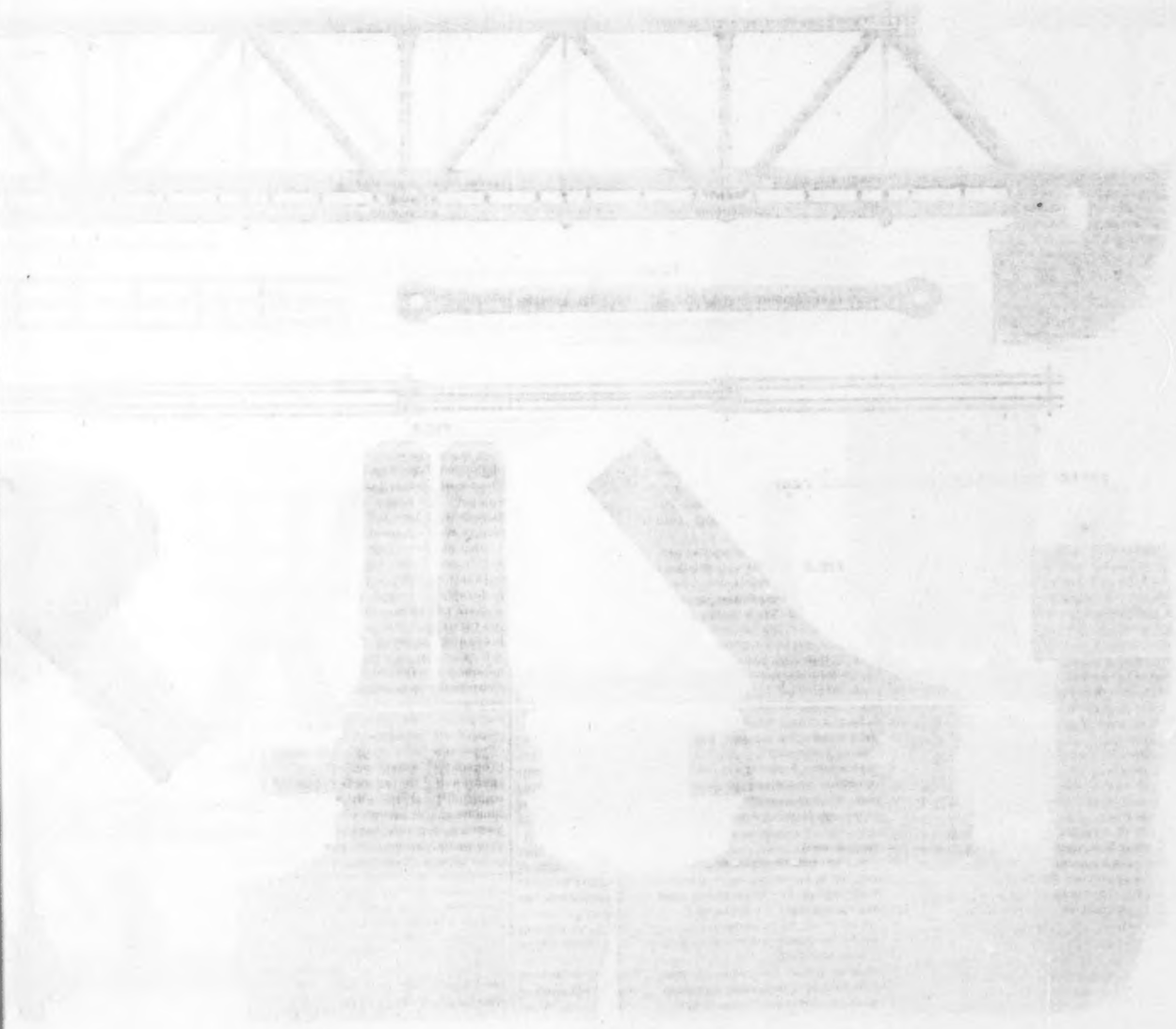

the gas passages connecting the body of the furnace with one of the gas regenerators. Referring to this view and the corresponding transverse section and sectional plan it will be seen that the gas after leaving the regenerator enters the body of the furnace through two flues or openings about 3 ft. 6 in. apart from centre to centre, these openings being somewhat bell-mouthed as shown in the sectional plan. The air, on the other hand, passes from its regenerator through three vertical flues which lead into a broad but shallow inlet flue having an opening into the furnace 5 ft. 9 in. wide by 6 in. high. The air is discharged from this opening immediately under the furnace crown, and the gases thus form a partial shield between it and the iron which is being heated, and thus tend to protect the latter from the contact of free oxygen. The products of combustion pass off at the other end of the furnace through similar openings to those through which they were admitted, being led through one pair of regenerators to which they impart their heat. At certain intervals, as is well known, the direction of the currents is reversed, the pair of regenerators which had been heated by the escaping gases being employed to heat the incoming gas and air, while the other pair of regenerators are in their turn being heated by the escaping products of combustion.

The manner in which the supplies of gas and air are regulated is shown by the transverse section Fig. 2 on page 320, a view which also shows the reversing valves. Of the two flues shown on the right-hand side of this view, the upper is the gas-flue leading from the gas producers, and the lower a flue communicating with the chimney stack which serves for the whole group of furnaces as shown in the general plan of the works on page 298 of our last number. From the gas flue the gases pass into a cast-iron casing provided with a conical valve which can be raised or lowered by a screw and which is fitted to the mouth of a vertical descending pipe. This valve governs the supply of gas to the furnace, while an adjacent valve fitted to the mouth of another vertical pipe, as shown, controls the admission of air. From each of the vertical pipes just mentioned are led off laterally two branches, communicating with the two gas regenerators and two air regenerators respectively, and just at the point where these branches join the vertical pipes are placed the reversing valves. These valves are of the disc form, similar to common throttle valves, and when closed form an angle of about 45° with the axes of the pipes in which they are placed. When the reversing valves occupy the position shown in Fig. 2 the air and gas pass over the tops of the reversing valves and enter those branches which are removed by the plane of the section, while at the same time the two branches of which the mouths are seen just below the valves are placed in communication with the chimney flue. When the reversing valves are shifted, by means of the levers attached to their axes, so as to be inclined in the opposite direction, those branches which were previously receiving gas and air respectively are placed in communication with the chimney flue and *vice versâ*. The opening to the chimney flue is controlled by a sliding damper which can be raised or lowered by a screw as shown.

The advantages of the Siemens system of regenerative gas furnaces when applied as heating furnaces in iron works have been so frequently pointed out in our pages, and are, however, so generally acknowledged that it will be unnecessary to dwell upon them here. We need merely remark, therefore, that at the Britannia Works, the construction of these furnaces and their gas producers has been carried out in accordance with the teachings of the most recent experience, and that every care has been taken to adopt the arrangements best suited to the work to be done. The manner in which the furnaces are disposed two and two, with broad avenues between the alternate pairs, is shown by the general plan on page 298 of our last number.

(To be continued.)

RAILWAYS IN VICTORIA.—For the first time in the history of Victoria the manufacture of locomotives has been undertaken by local makers, as stated in last week's ENGINEERING. Tenders were recently called for the construction of ten engines relating to the North-Eastern Railway of Victoria and the competition was confined entirely to Victorian contractors. Six tenders were altogether sent in, three from Melbourne and three from Ballarat, the lowest being that of the Phœnix Foundry Company, Ballarat. The price was 2900*l.* per engine.

NOTES FROM GERMANY.

BERLIN, Nov. 13, 1871.

THE HODGSON WIRE TRAMWAYS.

AN Hungarian engineer, Mr. T. Bush, has made some improvements on the Hodgson system of wire tramways by employing two parallel cables instead of one. The modified system, it is said, possesses great advantages over the original one, especially with regard to the carrying of heavy loads, and the greater security of the ropes.

METAL FOR BEARINGS.

The following alloy has been found to give highly satisfactory results for plummer blocks, axles, brasses, &c. To 30 parts of melted copper are added 70 parts of antimony; the mixture is melted, and run out into thin plates. These are then remelted with tin in the proportion of 90 parts of tin to 10 parts of the copper and antimony, and run out again into thin plates. When used it is remelted, and run into the forms required. M. Volk, of Regensburgh, has employed an alloy for many years of which the following are the component parts: Copper, 5.6 per cent.; antimony, 11.2 per cent.; and tin, 83.2 per cent. He also employs the following mixtures to produce metals for various purposes.

For slide valves:		
Copper	81.9	per cent.
Tin	14.8	,,
Zinc	3.3	,,
	100.0	
or		
Copper	67.8	,,
Old brass tubes ...	22.0	,,
Tin	10.2	,,
For pump barrels, stop-cocks, and valve-boxes:		
Copper	87.7	per cent.
Zinc	10.7	,,
Tin	1.6	,,
For stuffing-boxes, valves, &c.:		
Copper	86.2	,,
Zinc	3.6	,,
Tin	10.3	,,
For eccentric rings:		
Copper	90	,,
Zinc	10	,,
For piston rings:		
Brass cuttings	94	,,
Copper cuttings ...	6	,,

COAST PROTECTION BY TORPEDOES.

Contact and electric torpedoes were both employed for the protection of the German coast during the war. The former had generally a charge of 82 lb. of powder, and were moored about 3 ft. below the surface of the water. The electric torpedoes were loaded with 220 lb. of dualin, equivalent to 1100 lb. of powder, and were fastened 8 ft. below the water. The explosion of these was brought about by means of batteries placed on the shore, and they were perfectly safe. On the other hand the contact torpedoes were exceedingly dangerous to handle, and three fatal accidents took place in lifting them from their positions. In addition to the defence torpedo attempts were made to project others beneath the hulls of the hostile vessels, but nothing resulted from this application.

DYNAMITE IN WELL SINKING.

In Denmark dynamite has recently found a novel application, namely, in the sinking of artesian wells. During the autumn of last year some persons sinking a well at Gjeddesdal struck upon a very hard bed at a depth of 75 ft., which they were quite unable to pierce. As there appeared no choice but to abandon the work, they ultimately determined to try the experiment of a charge of dynamite.

After the bore-hole had been cleared, a bottle containing about 2.2 lb. of dynamite was lowered. It was attached to two copper wires passed through the stopper of the bottle, and insulated by gutta-percha. When the charge was in position an electric spark brought about the explosion, with the result of a great concussion on the surface, and an upward discharge of the water which stood in the boring. The hole almost immediately filled with water, giving evidence that the obstruction had been removed, and the source of supply reached.

Two charges were afterwards fired in a similar manner, and the sudden rush of water left no doubt about the successful issue of the experiment.

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The following are the general dimensions of the structure:

	ft.	in.
Total distance, back wall to back wall of masonry	170	4½
Width of bridge seat on abutments ...	4	8
,, ,, pier	6	6
Distance centre to centre of end pins in one span, measured on the lower chord	62	6
Number of panels in each truss ...	6	
Length of each panel	13	9
Height of truss, centre to centre of chord pins	8	3
Distance between trusses, centre to centre	14	0
Height from top of masonry to base of rail	2	7

In proportioning the different parts of the structure the variable load was assumed at 1½ tons per foot lineal of each track, the middle truss being calculated for both tracks loaded. The ultimate strain for wrought iron was taken at 30 tons per square inch of section for tension, and 18 tons for compression in the case of short prisms, the well-known formulæ of Gordon being used in computation of columns. The factor of safety adopted throughout was six.

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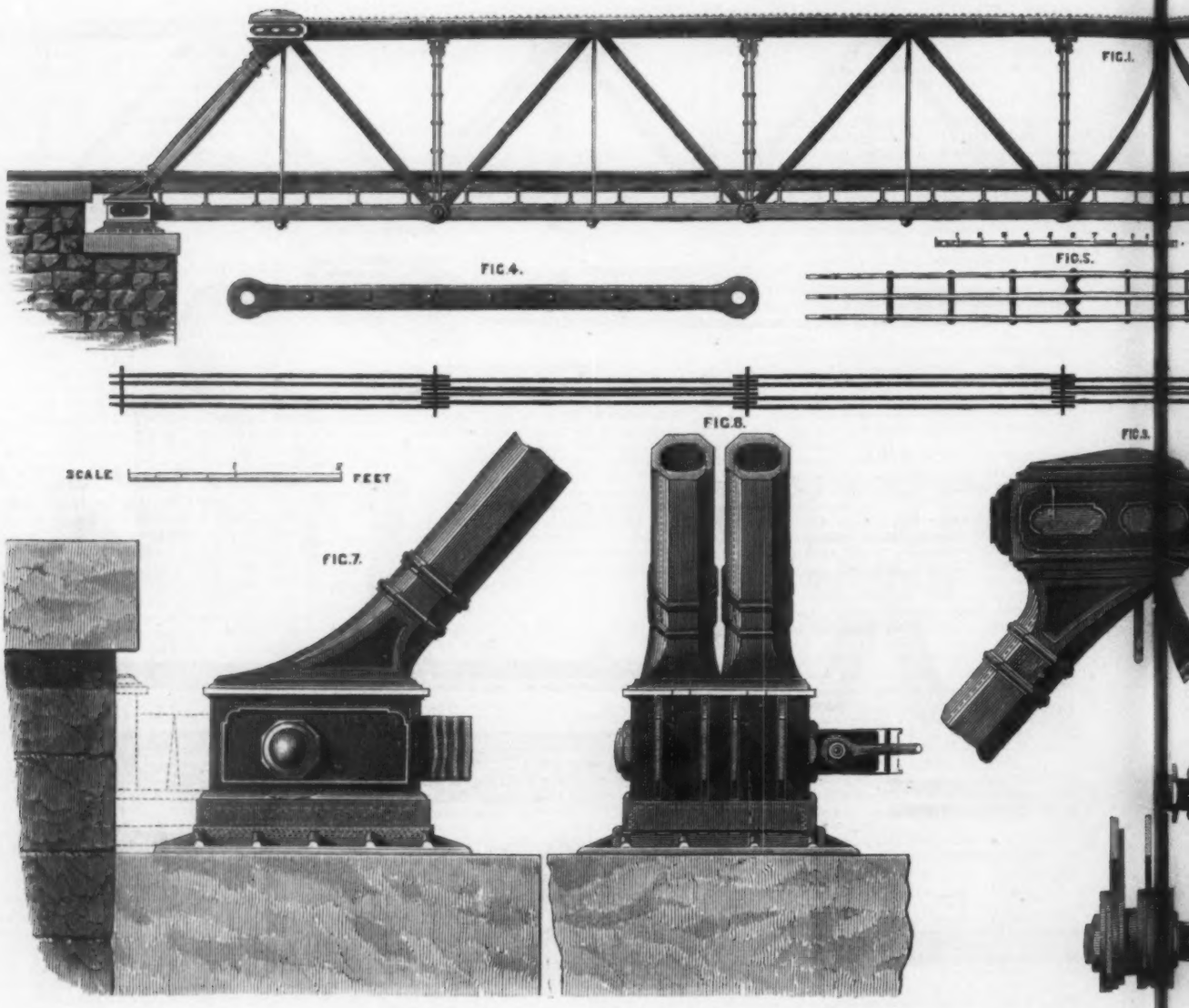
BRIDGE OVER THE LITTLE JUNIATA RIVE P

MESSRS. JOSEPH M. WILSON AND HENRY PETTIT, ENG RS;

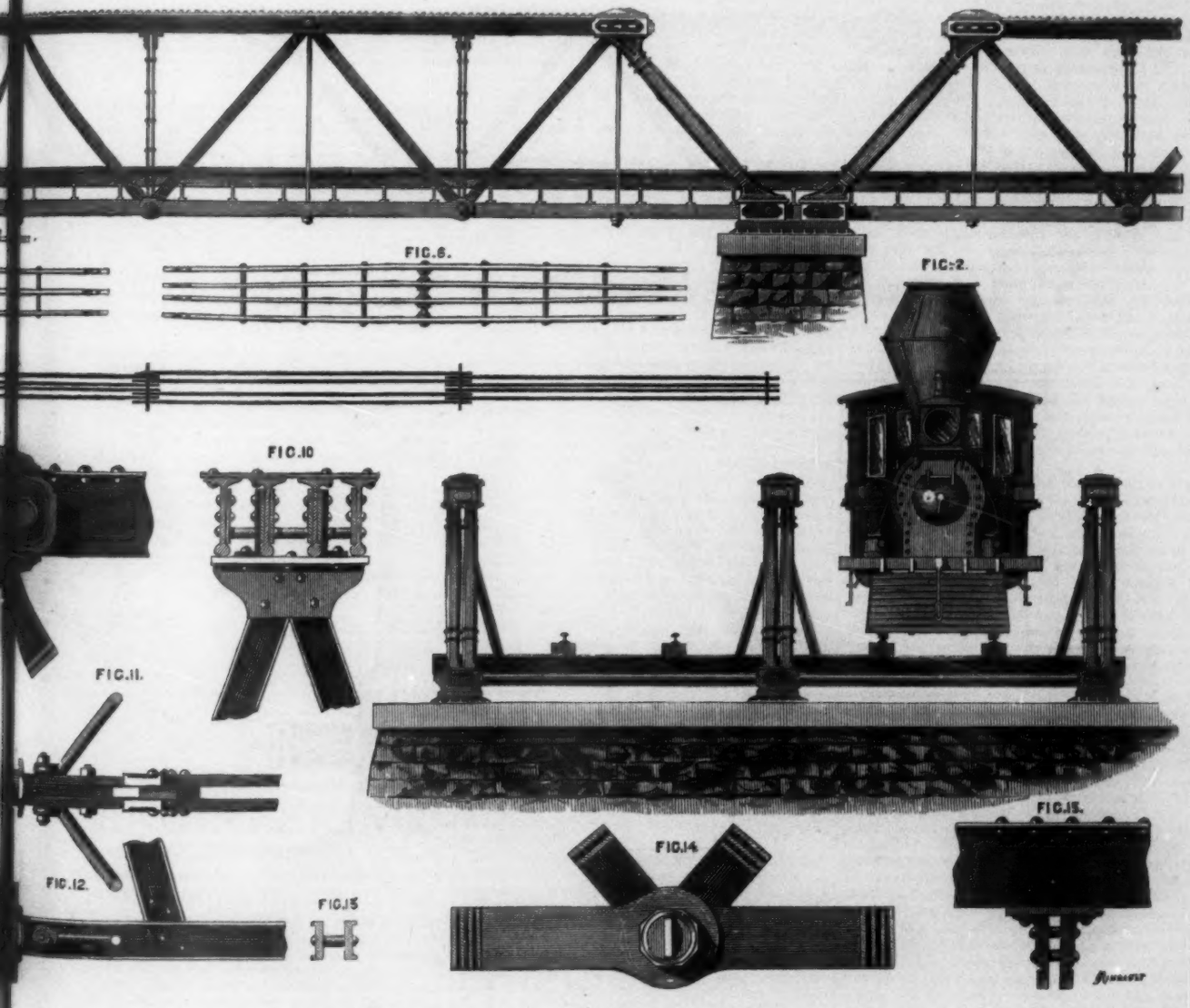
(For Descri n P



PENNSYLVANIA CENTRAL RAILROAD, U.S.A.

RS; THE KEYSTONE BRIDGE COMPANY, CONTRACTORS.

Page 322.)



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ENGINEERING is registered for transmission abroad.

NOTICE OF NEXT MEETING.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, November 21, at 8 p.m. 1. Discussion on "Pneumatic Despatch Tubes." 2. "On the Stresses of Rigid Arches and other Curved Structures." By Mr. William Bell, M.Inst. C.E.

ERRATUM.—We regret to have to correct a somewhat careless mistake which occurred in our article on "Locomotive Working Expenditure" last week (*vide* page 305). In speaking of the relation between the expenditure for fuel per engine per annum in the case of the Metropolitan Railway and that on other lines, the average expenditure per *half-year*, as given in Table on page 310, was inadvertently taken as a divisor in place of the average expenditure per annum. The error is an annoying one, but it is an obvious one from the context. The error necessitates the following corrections: The middle column of page 305, line 40 from bottom, for "seven" read "three and a half," and for "ten" read "five;" also in line 36 from bottom of the same column, for "700*l.*" read "350*l.*," and in line 19 from top, for "142*l.*" read "144*l.*"

THE "ENGINEERING" DIRECTORY is published this week on the thirteenth page of our advertisement sheet.

NOTICE TO AMERICAN SUBSCRIBERS.

In consequence of the great increase in our American connexion, we have found it necessary to establish a branch office in the United States. Communications may in future be addressed to MR. GEORGE EDWARD HARDING, C.E., *of 176, Broadway, New York, who is our accredited representative.*

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of 1*l.* 14*s.* 8*d.* ($8.32, gold) per annum, payable in advance.*

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ENGINEERING.

FRIDAY, NOVEMBER 17, 1871.

INTERNATIONAL COMMUNICATION.

THE travelling public this side of the Atlantic, especially the English travelling public, are very patient and long-suffering. Americans understand how to reduce the inconveniences of travel to a minimum, and to provide luxurious accommodation at a moderate cost to every traveller, whether by railway or by river; fitting up cars, in the one case, with a degree of completeness and comfort unknown out of the country, and equipping floating palaces, whereof the magnificence must be seen to be believed, in the other. That railway collisions are frequent, and disastrous river boat explosions are not unknown, does not by any means affect the matter. Comfort in travelling is an affair separate from safety; the former, as we say, is thoroughly understood in the States, the latter will probably come in time.

On the other hand the British public, with far greater means at their disposal, and a boasted superiority in matters of taste and refinement, are content to submit to many easily obviated railway discomforts; have only lately, and under protest, admitted improvements in passenger street traffic; continue to support a service of river boats which are a disgrace to the Thames, and to everyone who has to do with them; and year after year passes in idle discussion upon improvements in our international communication, while nothing is done, and the many thousands of Channel passengers remain subjected to all the inconveniences of a service against which for years past the whole civilised world has cried out.

During several years Mr. John Fowler has endeavoured fruitlessly to bring this most essential reform into a practical shape, and while a heap of nonsense was being talked concerning the construction of a tunnel for joining the two countries, he was engaged in the attempt to encourage French co-operation to bring about the only sensible and efficient means of establishing a successful service at a reasonable outlay.

Our readers are aware that the Channel Ferry scheme was worked out in the fullest detail, and it is almost certain that, had it not been for the disaster which befel France, the undertaking would now be advancing towards completion. For it is essentially an international work, and despite the general French objection that England would be the principal gainer by the work, there was not wanting abundance of support on the other side of the Channel which would have developed itself worthily but for the untoward course of events.

It is scarcely necessary to say that the undertaking is not dead, but only sleeping for the present in this country, and if public interest can be awakened sufficiently to press forward a work which has for its sole object the public advantage, it is probable that before long the International Communication scheme will be carried out. Meanwhile engineers are busy on the other side of the Channel, and the French Government is assisting them. M. Dupuy de Lôme is at the head of this undertaking, which is just now being warmly discussed in the department of the Pas-de-Calais. The project, which would be carried out by the Société des Forges et Chantiers de la Méditerranée, is as follows:

First, the creation at Calais of a maritime station with 16 ft. 6 in. depth of water at the lowest tides, and about 30 acres area (in connexion with the shore by an iron railway jetty, making a junction with a branch of the Northern Railway), and open to the sea by an entrance 260 ft. wide, accessible in all weathers and at every stage of the tide.

Second, the construction for crossing the Channel of steam vessels of large dimensions, and of great power, embracing all of the most important conditions of speed and comfort, and able to carry 30 passenger carriages or goods wagons. These vehicles would be placed on a double line of rails, running fore and aft; they would be shipped and unshipped by the assistance of a system of inclined planes leading to three landing stages of different heights, and alongside which the ferries would run, according to the state of the tide.

The speed of the boats would be 18 knots, and the crossing would occupy 70 minutes. The period necessary for constructing the works is estimated at two years, and the outlay at 430,000*l.* The three ferry boats required for the service would cost 400,000*l.*

This praiseworthy energy on the part of the French Government ought to encourage similar action in England. It would be, to say the least, discreditable to ourselves that France, especially at the present time, should actually commence the work that has been so long talked about, and in which we are principally interested. And it is earnestly to be desired that no conclusion should be arrived at on either side, except with the joint action of both English and French engineers. The benefits to be derived will be international, and the work should be carried out under international auspices. The plans of M. Dupuy de Lôme are well considered, but they lack much of the completeness which characterises Mr. Fowler's design, and we do not consider it probable that, however anxious France may be for the completion of this work, she will be able to carry it out unaided; the moment should therefore be seized for pressing forward the matter, now that she shows a real desire for helping forward the undertaking.

OUR HEAVY AND LIGHT ARTILLERY.

THE satisfactory results of the firing of the 35-ton gun since its enlargement have so enchanted the Government, that we hear it is contemplated to enlarge the calibre still further. Not content with burning all the powder, obtaining low pressures and high velocities, the authorities appear to be desirous of going a step further. With what object it is hard to say, but with what result it is easy to predict: namely, the probable destruction of the gun. If, as we recently pointed out, the enlargement of the bore of the gun from 11.6 in. to 12 in. involves, as it does, a corresponding shortening of the 700 lb. projectile, which will lead to unsteadiness in flight, greater air resistance, and a reduction of penetrative power, what must the further increase in calibre enlargement do? We certainly consider the gun as already sufficiently spoiled for all purposes of correct shooting, without further experiments being tried on it in the direction of enlargement. For our own part we cannot conceive why the gun was not sent to be tried at Shoeburyness for range and accuracy before it was enlarged at all. The Committee on Explosives are well aware that when its calibre was 11.6 in. they obtained pressures of 21.7 tons per square inch on the projectile, 20 tons per square inch at the vent, and 1353 ft. initial velocity per second, with 120 lb. of pebble powder. They must also know that they have not been able to obtain less than 25 ton pressures, nor more than 1355 ft. velocities from 115 lb. charges with the gun since its enlargement. The contemplated alteration will further remove the possibility of ever rendering it a useful weapon. We hope, however, that better councils will prevail, and that the gun will at once be sent to Shoeburyness for trial at the targets, in order to decide how far its shooting has been impaired already. The officials at the royal gun factories are desirous that it shall be sent there, as they wish to proceed with the manufacture of the other 35-ton guns now arrested in various stages of progress pending the decision of the committee as to the most suitable calibre. We hope the committee will pause ere they again send the gun to the boring mills, for they ought to know that low pressures and high velocities at Woolwich may possibly mean want of accuracy and low penetrative power at Shoeburyness.

The 10-in. gun with which the committee are experimenting at the proof butts, Woolwich Arsenal, was recently fired with 70 lb. of powder and a 1000 lb. projectile. This bolt was fitted with studs to take into the rifling of the gun, and when the piece was loaded the shot projected beyond the muzzle. Notwithstanding its great length it preserved its balance on its longer axis, and buried itself point foremost in the butt. It cut holes through the velocity screens as clean as round shot would have made. In all respects the gun came well out of this ordeal; the committee, however, have further trials in store for it.

Turning to guns of a lighter class we have first to notice some satisfactory trials which have recently been made at Shoeburyness with the 16-pounder muzzle-loading rifled field gun. These guns weigh 12 cwt., and are rifled in three shallow grooves similarly to the 9-pounders. The shape, however, differs from that of the latter, there being no swell at the muzzle. The sighting also is different, occupying a central position on each of the trunnions. There is also a clever arrangement for securing the screw which tightens the rear sight. In lieu of the old chain which frequently became detached there is an arm upon the head of the screw which catches against a button on the surface of the breech as it unwinds itself, and prevents the screw from making more revolutions than are actually requisite. The carriages, limbers, and ammunition wagons for these guns have also been improved in detail. In the recent experiments the gun charges were 3 lb. of R. L. G. powder, and the projectiles in the first series were common shells, with Royal Laboratory screw percussion fuzes, the range being 2500 yards. Four rows of targets were set up 20 yards apart, each row being 54 ft. long, and 9 ft. high. Out of ten rounds fired one was blind, the nine giving as a result per shot on the four targets (which were placed to the rear of each other) 7.0 throughs, 2.1 lodges, and 0.9 strikes. In the second series Shrapnel shells with R. L. screw percussion fuzes were fired with 3 lb. gun charges. Ten rounds were fired, one shell burst beyond the

targets, and the remaining nine gave per shot 23.4 throughs, 12.1 lodges, and 4.0 strikes. The third series consisted of 10 rounds with Shrapnel shells, having wood time fuzes, and fired with 3 lb. powder charges as before. Two rounds proved blind, the eight effective shots giving 36.6 throughs, 9.9 lodges, and 20.0 strikes per round. These results speak well for the range, power, and accuracy of the new 16-pounder gun, which has yet to undergo further trials at still greater ranges.

We have next to notice a new gun of a class, the introduction of which into the service has been contemplated for some time past. This is a powerful rifled howitzer, the example at Shoeburyness—the first of its kind—weighing 46 cwt., and having a bore of 8 in. diameter, with an uniform rifling of 1 turn in 16 calibres. It is mounted on a wrought-iron carriage weighing 27¼ cwt., and fitted with removable wheels, the gun being worked from a wood ground platform. This gun so far has been tried for range and accuracy of fire with common shells weighted to 180 lb., and plugged. In the first of two series of experiments 29 rounds were fired with charges varying from 1 lb. to 8 lb. of R. L. G. powder. The mean ranges obtained were from 491 yards, with 1 lb. charges to 4328 yards, with 8 lb. charges. In the second series 18 rounds were fired with 8 lb. powder charges at an elevation of 40 deg. 5 min. recoil checked, the mean range being 4283 yards, and the mean time of flight 27.0 sec. Two rounds with 10 lb. of powder, at the same elevation as before with the recoil checked, gave as a result: mean time of flight 30.1 sec., and mean range 5134 yards. The accuracy of the gun was fully equal to what could be expected from firing under the conditions of the above experiments.

CANADIAN PETROLEUM.

During the last twenty years rapid advances have been made in the development of mineral oils, and their growing importance for illuminating and various other purposes gives them a high commercial value. The natural oils which flow from the earth were familiar to the ancient inhabitants of the world, both civilised and barbarous. Thus Herodotus, who wrote 440 years B.C., mentions a place called Arderrica, thirty-five miles from Susa, where there were wells yielding bitumen, salt, and oil. The products of these wells were drawn off in utensils formed of wineskins, cut in halves, and were allowed to settle in tanks. Here the bitumen and salt settled and hardened, the oil being drawn off into casks. This oil was known to the Persians as "Rhadinace;" it was black and had an unpleasant odour. The Persians, Burmese, and other nations still continue to employ these substances in their crude state to give light and for medicinal purposes. In 1694 we have it recorded that Messrs. Eecle, Hancock, and Portlock obtained a patent for making "pitch, tar, and oyle out of a kind of stone." In 1761 oils were distilled from black bituminous shale, and were used medicinally, as stated in "Lewis's Materia Medica" for that year. More than a century ago oils were obtained by the distillation of coals, but the purification of those oils and their application to the common requirements of life have progressed but slowly, and have hardly yet reached perfection.

The first successful attempt to manufacture oils from coals in America was made by Dr. A. Gesner, who made and consumed this oil in lamps in 1846. His inventions are known as the kerosene patents, and were purchased by a company, and worked in the production of kerosene oil. Although great advances have been made in this class of apparatus, it can hardly yet be said to be so perfect as to meet the general approval of manufacturers. When once started, the production of oils from bituminous substances extended very rapidly to the chief cities of the Atlantic seaboard, as well as to those of the coal districts of the interior. The great cheapness of the oil obtained by the distillation of petroleum has, however, almost caused the coal distillation to be suspended. It will probably only be resumed when the petroleum wells cease to yield sufficient oil for the various purposes to which it is now applied. Ten years since a calculation was made which showed that whenever crude petroleum reached an average price of 35 cents per gallon in the American markets, the coal distiller could afford to resume business.

But although at the present time there is an abundant yield of petroleum, there is an enormous amount of waste going on in the process of rendering it commercially useful. In the Dominion of Canada—to the oil wells of which we now more particularly refer—this waste arises from the present imperfect methods of manufacture, and reaches the enormous amount of 40 per cent. of the crude oil. It is estimated that the surplus crude oil of the Dominion now unsaleable, reaches 350,000 barrels per annum. Besides the waste resulting from the present modes of manufacture, the finished oils produced in Canada possess a very offensive odour, owing to the presence of sulphur and arsenic in the crude oil. This has been neutralised by chemical means, but only temporarily, as the odour invariably returns, the results of the treatment not being permanent. The United States crude oil is much purer, and consequently sells at a higher price.

The great waste to which Canadian oil is subject is, however, likely to be checked, and the 40 per cent. of residuum of the ordinary makers to be profitably utilised. This anticipated saving will be effected by an improved distilling apparatus which has been invented by Messrs. Houghton and Howell, of St. Catharine's, Ontario. By means of this apparatus the waste of other makers is not only utilised, but the most valuable products are obtained therefrom. From this waste material a lubricating oil of very high quality is produced. From long trials of this oil, it is affirmed that it is not decomposed nor dried up in steam cylinders; that it is not injurious to iron; and that it will not oxidise. It, moreover, produces no acid reaction, remains perfectly limpid at 2° below zero, and is not explosive nor inflammable. By the new process the arsenic and sulphur are entirely removed from the carbon oils, which are perfectly and permanently deodorised. But beyond the deodorisation and conversion of the waste of other makers, Messrs. Houghton and Howell utilise the crude oil to the greatest possible extent. The largest amount obtained by other Canadian refiners from the crude is 60 per cent., and their products are then very inferior. By the patent still and machinery a yield of from 90 to 95 per cent. is obtained, whilst at the same time both the illuminating and the lubricating oils possess a greater money value than do those obtained by the old mode of distillation.

The new process has been carried out in the Dominion for some little time past on a moderate scale, with success, but being capable of wide extension, additional works are now being constructed by an English company. These works are being erected at Port Sarnia, situated upon the river St. Clair, which connects the lake of that name with Lake Huron. They are about 14 miles from the great cluster of oil wells in Petrolia, and are situated on 23 acres of land, with an extensive river frontage. There is railway communication direct between the oil wells and the works, and competing lines between the works and other parts, besides which there is navigable water available for six months of the year, thus affording direct communication with all parts of the world. The machinery for these works has been supplied by an English engineering firm, who are now superintending its erection.

We have said that the new process has been in operation for some time past, and we may here add that the products are highly appreciated in the Ontario district, where they have been largely used. The efficiency of the lubricating oil was fully proved by Mr. C. Stovin, the general manager of the Welland Railway in Canada, and who, it will be remembered, was formerly traffic manager on the London and South-Western Railway. In the beginning of the present year Mr. Stovin had the oil put to a severe test on his line. The mail car came out of the shops with new brasses fitting tightly. The wheels on one side were packed with the new oil, and those on the other side with the oil in ordinary use on the line. The journals packed with the new oil worked themselves into their proper bearings without once heating. The car ran for thirteen days without a fresh supply of the lubricant, the boxes not being touched during that time. The journals on the other side heated badly, and had to be oiled every morning, and sometimes a midday dressing was found to be necessary. A trial of the oil on a locomotive engine was most satisfactory; it was carried on during very severe weather, even for Canada, and when no other oil would remain upon the machinery. The oil has also been used in England by several engineering firms with success, and bids fair to take its place as a valuable lubricant for machinery, and for railway axles. For the latter purpose especially there is a good opening for a really efficient lubricant.

RAILWAYS IN VICTORIA.

The colony of Victoria has been, as we showed on a previous occasion,* very hardly dealt with in the matter of railways. She possessed at the date of the article referred to, 254 miles of line constructed on a gauge of 5 ft. 3 in., at an average cost of 36,470*l.* per mile, inclusive of course of preliminary expenses, stations works, &c. Upwards of 9,260,000*l.* had been expended by the end of 1865 in building railroads for accommodating the light traffic of the colony, when one-fifth of the sum, even in the comparatively early days of Australian railway building would have been excessive. It would be difficult to find a more striking instance of the result of incompetence and extravagance than is illustrated by these works; no wonder, therefore, that the Government of Victoria are doing their best to proceed with due discretion, now that the question of railway extension is being discussed in the colony, and the construction of many new lines cannot be further delayed. We have already seen how Mr. William Elsdon was despatched by the Victorian Government to make a grand tour of railway inspection in order that advantage may be taken of every good thing that could be selected from current railway practice at home and abroad, and we have seen the result of this expedition.

Since Mr. Elsdon's return, a commission was appointed by the Government to receive evidence from all the available colonial talent, in order that a report might be framed to assist the authorities in deciding upon the steps that should be taken in the matter of railway extension. The recommendations of the Committee, as set forth at the conclusion of their report, are as follows: first, that in future contracts for railway extension, the expenditure should be restricted to a sum not exceeding 5000*l.* a mile, including stations and rolling stock. Second. That the traffic between Geelong and Ballarat, and Footscray and Sandhurst, should be worked for six months on a single line, and unless the result should be unsatisfactory, then the second line should be removed, and the materials used in the construction of branches to these lines, or such other lines as Parliament may direct. The other recommendations of the Commission are unimportant except that they counsel the Government to abstain from any change of gauge for the present.

It is scarcely necessary to point out, that no absolute rule can be laid down as to the exact cost of railway construction. It must vary with the nature of the country to be traversed, and while the sum mentioned will be ample with proper management to build a railway even of the extravagant gauge which is now to be perpetuated in the colony, there will be many sections where double the money will be probably found insufficient. We presume, however, that the Commission do not expect their recommendation to be accepted exactly in a literal sense.

The second suggestion, however, we may consider at greater length. The desire to gain experience as to the advisability of working the existing traffic on a single pair of rails is laudable enough, although we cannot understand why they require six months' experience to demonstrate the possibility of what has been already proved by thirty years' experience. However, we can understand the wish to proceed cautiously in any future railway reform. But the recommendation that if, after half a year's trial, it should be found possible—and that it will be found possible there can be no doubt—to work their business on a single track, that the other pair of rails should be taken up and relaid on new lines is one that passes our understanding altogether. Apparently it is the result of Mr. Elsdon's advice, who manipulates figures in a way truly surprising, to favour the advantage that is to be expected from this eccentric proceeding. His detailed estimate contained in an appendix at the end of the Committee's report, gives the whole of this brilliant scheme in detail. He proposes to take up 137 miles of single track with rails weighing 80 lb. to the yard (this was the weight with which fatuity burdened Victorian railways), worth, on his own showing, 124,200*l.*, and calculated to last with light traffic, 8 years from the present time; and he would lay them down

* *Vide* Engineering, vol. viii., page 231.

over 137 miles of line, where 45 lb. rails worth 82,500*l.* would serve the purpose far better. But the cost of taking up the existing 137 miles of single line would be about 20,000*l.*, therefore the Government would only have to spend 62,500*l.* in excess of what Mr. Elsdon proposes to waste in taking up the second pair of rails, to provide an entirely new road. Now if, taking his figures, the half-worn 80 lb. rails have still 8 years' life in them, there follows a fact apparently entirely overlooked by the Commission, namely, that, when the whole of the traffic now carried between Moorabool and Ballarat, and between Footscray and Sandhurst upon a double line, shall be concentrated in a single pair of rails, the wear will be increased in proportion, so that instead of lasting 8 years longer, the rails will be worn out in 4 years at the outside, less, probably, because the deterioration becomes more rapid in the last years of the rail's life. So that in four years' time new permanent way would be required for the 137 miles, and according to Mr. Elsdon, nothing less than a 70 lb. rail will suit the traffic. It is very possible then that these renewals will be made with a 70 lb. rail; and if so the Government will be called upon in 4 years to expend 128,000*l.* for new rails, when by providing less than half that sum now they would obtain a more efficient and suitable permanent way for their extensions.

We have quoted Mr. Elsdon's own figures, which are merely preposterous, and give no correct idea of the real condition of the case.

Thus he assumes the value of the old rails he proposes to remove to be 5*l.* 2*s.* per ton—an excessive price, and he makes no allowance for the loss upon locked-up capital represented by the value of these rails which would be lying idle for a considerable time, whilst the remaining pair were wearing out at twice the normal rate. But the most curious item in his estimate is the saving of 50*l.* a mile of line in the expense of maintenance—that is, he appears to consider that by taking away one pair of rails, and throwing all the traffic upon the remaining pair, the cost of maintenance would be reduced by nearly half. In the same way he gives full credit for the whole number of sleepers that would be left available for repairs of the single line. In this way he shows that in the saving of maintenance and sleepers alone in the 8 years assumed for the duration of the rails, no less a sum than 72,800*l.* would be accumulated, and the grand total of his proposed economy is made out to be 177,194*l.* 9*s.*! Of this amount the 72,800*l.* is purely imaginary, as we have shown, and whatever apparent saving could be made in the capital account, would be effected at an alarming cost, and with a result unsatisfactory to everybody.

We are quite willing to admit that some slight saving may manifest itself in working the traffic of the existing lines upon a single pair of rails, and with proper management the Government might husband the large supply of 80 lb. rails now laid down, and obtain the greatest possible service out of them. But not in the way Mr. Elsdon proposes. Supposing that his suggestion is carried out, we should be quite prepared to learn that further supplies of 80 lb., or at least 70 lb. rails were ordered from England to make repairs, not only on the existing lines, but also on the proposed extensions, and a new system of the most wasteful description would become a fresh feature in Victorian railway policy. The proper course for the Government to adopt, if they are determined to throw one pair of rails out of use, is to keep them on the railways where they will be wanted for repairs, and not to send them travelling up and down the country under Mr. Elsdon's auspices, finally, to be laid down on some light traffic extensions where they are not wanted. Such a simple, common-sense suggestion will not probably occur to the brilliant advisers of the Government. But if by any fortunate chance it should be acted upon the railway department would find a ready way to wear out the existing type of cumbrous permanent way, and gradually to introduce a lighter and more suitable section. It should be the first effort of the department to prevent the mistakes already made from spreading. We wish we were assured that there existed a fair prospect of so wished for a result.

With regard to postponing the adoption of any change of gauge, we can only regret that the Committee had not the boldness to recommend at least an experimental line of 3 ft. 6 in. It is true Mr. Elsdon tried hard to have the gauge reduced to 4 ft. 8½ in; why, is best known to himself. Ostensibly, his motive was that the colony might obtain the "Riverina traffic;" but when urged upon this point he considered it doubtful if the "Riverina traffic" would be secured by the change, and that if it were secured, it probably would not be worth having.

The saving to be obtained by the reduction of 6½ in. of gauge, he vaguely implied would be considerable; but, as he afterwards stated, that the saving of a 3 ft. 6 in. line over the 5 ft. 3 in. would not be more than 5 per cent. on the rolling stock, and less than 5 per cent. on the cost of construction, the only conclusion to be arrived at is that he did not understand what he was talking about.

Of course the Fairlie system formed one of the most prominent subjects of discussion by the Committee, but as the whole of the evidence consisted only of a repetition of what has already been discussed in this country, flavoured with Colonial superstition and prejudice, we need not refer to it in detail. It is sufficient to say that while these two elements are strong and powerful, there is a counteracting desire to do Mr. Fairlie all justice.

That the colony of Victoria will arrive at any speedy solution of her railway difficulties is almost too much to hope under present circumstances. It cannot well be otherwise while she has advisers who can inflict upon the Government such nonsense as the following Table, and lacks the common sense in the railway department that would prevent it from appearing in official records as a document of value.

TABLE SHOWING THE CARRYING POWER OF RAILS OF DIFFERENT FORM.—(*According to Mr. Elsdon.*)

Number.	Weight of rail in pounds per yard.	Form.	Materials.	Life in years.	Yearly percentage required for renewal.	Maximum load per wheel.	Maximum adhesion weight on four coupled drivers.	Limit of adhesion at one-fifth.	Diameter of cylinder in inches.	Length of stroke in inches.	Diameter of driving wheel in inches.	Adhesion weight on four drivers.	Weight on bogie.	Total weight of engine.	Pressure in boiler in pounds per square inch.	Pressure in cylinder in pounds per square inch.	Tractive force in pounds.
						tons.	tons.	tons.	in.	in.	in.	tons.	tons.	tons.			
1	45	⊥	iron	7	15	2.60	10.64	2.1	12	18	51	10	9	19	100	90	4,574
2	53	⊥	iron	7	15	3.7	14.8	2.9	14	20	51	14	10	24	100	90	6,017
3	53	⊥	steel	21	5	5	20	4	15	22	54	20	10	30	100	90	8,250
4	70		iron	14	7½	6.5	26	5.2	16	22	54	24	10	34	100	90	9,386
									17	24	60	26	11	37	100	90	10,404

This Table speaks for itself. We may, however, call attention to the fact that it is usually supposed that the amount of traffic passing over a rail has something to do with its duration, and that new rails, when first laid down, do not generally require the same percentage of renewals as when they are nearly worn out. Possibly the singular information concerning the pressure of steam in the boiler and cylinder, with reference to the duration of rails, and the precise dimensions of driving wheels, may have some importance in Victoria. We fail to see its value here.

WAITAKI AND MOERAKI (N.Z.) RAILWAY.—This line has been officially surveyed, and will probably be proceeded with in a few months. The length of the line will be 40 miles, and the cost will be 172,000*l.*, exclusive of any jetty or harbour works at Moeraki or Oamaru. Immense deposits of Oamaru building stone are expected to afford a valuable revenue to the line. The only expensive bridge over the line will be that over the Kakanin, and the cost even of this will not be very serious.

FRENCH RAILWAYS.

WE return* to the injuries inflicted upon the system of the Western of France Railway Company during the progress of the late unhappy events in France. On the Versailles line on the left bank of the Seine, the Montparnasse and Vaugirard stations, which were but little affected by the fire of the Prussians, suffered greatly from the Parisian insurgents. The façade of the Montparnasse station, in the Rue des Rennes, was damaged by obuses from a barricade placed near the church of St. Germain des Prés, and discharged against a battery established by the regular troops in front of the station. The portion of the left bank Versailles line, between the fortifications and Clamart, was the theatre of military operations, the consequences of which were the destruction of most of the works upon the line. The West-Ceinture Station, which was under the fire of Fort Issy, was very greatly damaged. As regards the Clamart Station, it appears to have entirely disappeared during the combats which took place round Fort Issy. The Havre line suffered only from the Franco-German war, but the damages which it sustained were nevertheless of a serious character. Thus the Bezons Bridge over the Seine was nearly destroyed; a temporary bridge has replaced this work, which commands the communication between Paris and Normandy. The viaduct over the road from St. Germain to Argenteuil was destroyed by the Prussians; it has been temporarily reconstructed of timber. The Mantes Station was the theatre of a combat, at the close of which the buildings and their internal fittings were sacked by the Prussians. The French military engineers blew up about 100 ft. of the Rolleboise tunnel in order to prevent the Germans passing through it. The traffic has been re-established, but the masonry will have to be reconstructed, and this urgent work has been in course of execution for several weeks past. The Bonnières station, like that of Mantes, was burnt. The Ectot viaduct, between the Motteville and Yvetot stations, was destroyed by the Germans, as was the Bolleville viaduct between the Alvimare and Balbec-Nointot stations. One of the most important works on the company's system is the Mirville viaduct on the line between Paris and Havre; this viaduct is composed of 46 arches, having openings of 28 ft. 6 in. each, and 66 ft. to 110 ft. in height. It was scarcely to be expected, perhaps, that this fine structure should pass through the war without injury, and it is accordingly not surprising to find that three of the first arches on the side of Paris were destroyed by the Germans. A temporary wooden structure has assured the passage of trains during the progress of definitive repairs, which have been in course of execution in the course of the past summer. The line from Serquigny to Rouen, uniting Normandy to the west and south of France, was damaged in its principal work, the Orival viaduct over the Seine, near Elbeuf. This fine structure was composed of six iron spans, the two shore spans being 118 ft. 10 in. each in length, while the four intermediate spans were each 158 ft. 8 in. in length. The viaduct was attacked at several periods by the Germans, who after having blown up two of the tubular piers endeavoured to cut the road-bed at some points, and at last brought down the second and third spans on the Elbeuf side. As if the work of destruction were not then sufficiently complete, fresh mining operations were commenced, and grave injuries were inflicted upon all the other spans, except the first, on the Serquigny side. As the temporary repair of this important viaduct would involve too heavy expenses, the directors have been proceeding with the definitive reconstruction of the work, utilising as much as possible the old materials. The line from Mantes to Caen was scarcely less badly treated than the Havre line. The station and village of Broval were burnt, and the Martainville tunnel was partly blown up. The Groslay viaduct over the Rille, between Romilly and Beaumont-le-Roger, a work of seven arches, of 33 ft. 4 in. opening, and 66 ft. 8 in. in height, was entirely destroyed, as was a viaduct of four arches over the Dives.

Such was the fate of the company's line assuring communication with Caen and Cherbourg. We might prolong the details of the destruction wrought, but it will probably be considered that we have done quite enough in recapitulating the more important injuries inflicted. As regards the line from Virofiay to Rennes, it may be added that the Versailles station and its accessory buildings

* *Vide* ENGINEERING, page 254 of the present volume.

were damaged. The Landelles viaduct over the Eure, between the Courville and Pont-Gouin stations, was overthrown. The Chartres and Mans stations, successively occupied by the belligerents, experienced disastrous consequences. The viaduct on the line from Assé to Sainte Suzanne, between the Voultré and Evron stations, was destroyed. On the St. Cyr and Surdon line the Chérizy viaduct was partly carried away by mining. The Nonancourt station was sacked after a combat carried on in its environs. The Rille viaduct, about 1¼ miles from the Laigle station, was cut. On the line from Le Mans to Mézidon a viaduct over the Sarthe, about 1500 metres from Le Mans station, was destroyed by the French army on the approach of the Germans. A viaduct over the Orne, near the Sees station, was destroyed by the Germans. On the line from Le Mans to Angers the Suze viaduct over the Sarthe had one arch cut; and the Loutinières viaduct over the same river lost two of its arches. We have traced only a few of the principal damages inflicted on the system, but in the districts exposed to the German war, and also to the civil war, there is scarcely a portion of the permanent way and works which do not bear traces of the fearful storm of disaster and ruin which swept over greater part of France during the winter and spring of 1870-71. The directors have, however, applied themselves vigorously to the restoration of the damages inflicted; and except at two points—viz., the passage of the Seine at Argenteuil and at Elbeuf—all communications are now re-established, the movement of passengers and goods has resumed its ordinary course, and the disasters of the war may be said to have been in a great measure effaced. Nevertheless they leave behind them heavy pecuniary charges which have now to be provided for. The loss extended not only to the way and works of the undertaking, but also, of course, to the rolling stock upon it. The exceptional nature of the traffic service carried on last year frequently involved a concentration of locomotives at points without any proper shelter for engines, or at any rate affording very insufficient shelter. The engines were thus exposed to the inclemencies of the winter and could only receive a very imperfect amount of care and attention, so that they frequently had to be set to work in a bad state. The keeping of a great number of engines almost constantly in steam in order to provide for the eventualities of a variable and unforeseen service prevented the washing out of their boilers at the proper time, and exceptional injuries resulted in consequence. Similarly, the passenger carriages sustained a good deal of harm from the rough usage which they experienced during the war, some of them having been even used for sleeping and cooking purposes; the trains made up were also of great length, as many as 75 carriages being sometimes collected together, the result being frequent breakages of couplings, &c. The other rolling stock of the company also suffered in all kinds of ways; not the least being the appropriation of engines and stock by the Germans.

THE PARIS WATER SUPPLY.

In 1854 it was decided that the city of Paris should be supplied with water from the chalk districts of Champagne and Brie. A long time was, however, consumed in deciding upon the details of the project and elaborating them, so that it was not until 1860 that the city bought eleven groups of sources, of which three had a height sufficient to insure an ample gravitation supply to the most elevated parts of Paris, whilst the water from the other localities was to be raised by pumping engines to heights varying from 60 ft. to 65 ft. The city also purchased 1250 acres of land, and 19 mills, besides all the ground required for the construction of aqueducts, &c. The contract plans for the works, approved in 1865 by the Municipal Council, led the water to the Montrouge reservoir, at a height of 262 ft., by aqueducts in béton of a circular section, and 5 ft. 6 in. and 5 ft. 10 in. in diameter, crossing the valleys by syphons. There is, for example, near the Bourg de Pont a syphon 10,570 ft. in length. At St. Jacques the aqueduct is tunnelled through a marble of great hardness; then follows the syphon of Loing, carried along the bottom of La Vallée on 53 arches. The sands of the forest of Fontainebleau are traversed for 15 miles almost on a straight line; and this part of the work was attended with great difficulty on account of the unreliability of the foundations. The line then follows the limestone formation on the left bank of the Seine, and crosses the valley of Essones by a syphon. The valley of the Orge is also crossed in the same way, and then by cuttings and tunnels the aqueduct of Arcueil is reached at a height of 124 ft. 8 in. above the bottom of the valley. The total length to the reservoir of Montrouge is 108 miles, of which 13.45 miles are in syphon, 26.20 miles are in tunnel, 10.35 miles are on arches, and 58 miles are in cutting. Of the work, 88.6 miles are completed, and 19.4 miles remain to be done. The amount already paid is 20,700,000 francs, and a balance of 20,000,000 has yet to be met. The importance of pushing the works on to completion cannot be overrated, for they will bring to Paris an abundant supply of good water, which, in conjunction with the proposed sewage reforms now being discussed, will effect improvements in the sanitary condition of the city, which are now so greatly needed. Moreover, when completed, the supply of water to the inhabitants may be made a source of profit to the Municipal Government.

LITERATURE.

The Workman's Manual of Engineering Drawing. Price 4s. 6d. By John Maxton. Lockwood and Co.

This book supplies what has long been wanted, a good, practical, and low-priced treatise on engineering drawing. Commencing with a description of how a drawing office should be fitted up, Mr. Maxton proceeds to impart to the draughtsman a variety of valuable information concerning the materials and tools he will require to make use of, such as drawing-boards, squares, instruments, scales, colours, paper, &c. He next tells him how to prepare his paper and how to ink in his drawing, how to shade and colour it, and how to border it and cut it off the board when finished, each of these subjects being treated in a separate chapter. In addition to this, there are chapters on practical geometry, projection of shadows, delineation of the slip and path of the screw propeller and paddle-wheel, on drawing tracings, for the use of engravers and photographers, and on diagrams for lectures, besides an appendix containing notes on architectural and ship drawing, and on perspective and isometrical projection, as well as on sizing, varnishing, &c. The whole is illustrated by a number of plates and by nearly 350 woodcuts. In fact, Mr. Maxton's book contains the results of the long experience of one who has acquired considerable reputation as a draughtsman, and the advice which he gives to the novice is invariably that which he has himself followed. There are, however, one or two defects in the work. For instance, in the chapter entitled "Hints on Geometry," several of the definitions might have been given in more mathematically correct language without losing any of their perspicuity. Nothing can be more erroneous, even in a book on mechanical drawing—which, after all, is founded more or less upon geometry—than to sacrifice rigidness of definition to a false notion of rendering the comprehension of a subject easier to the learner. In other places, Mr. Maxton's evident desire of full explanations results in a somewhat involved style of language which it would have been well to have avoided.

Probably, the best chapter in the book, though all are excellent, is that on the projection of shadows; commencing with the more simple shadows such as thrown by columns, &c. Mr. Maxton proceeds, by carefully graduated steps, to show how those on various curved surfaces may be found, and his exposition of general principles is here so clear that the most inexperienced draughtsman will be able by the aid of this part of the book to accurately determine any shadows required in ordinary engineering drawing. The chapter in the appendix on the detail drawings of steam ships also embodies many valuable hints. Although Mr. Maxton's book is intended chiefly for the instruction of students and working engineers, even accomplished draughtsmen will find in it much that will be of use to them, and a copy of it should certainly be kept for purposes of reference in every drawing office.

Victorian Coal.—Some of the coal discovered at Western Port, Victoria, appears to be of superior quality. The chief harbour-master (Captain Payne) recently tested a sample obtained from the Kilcunda mine on board H.M. C. S. Pharos and found that it answered well for steaming purposes, burning with a clear bright flame and leaving very few ashes. It was compared with the ordinary Newcastle coal, and was considered if anything superior. Captain Payne has suggested that the Colonial Government should take the Kilcunda coal into its own hands and develop it by means of convict labour.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Market.—Yesterday there was an excellent attendance on 'Change at Middlesbrough. Pig iron was exceedingly scarce, and those who were so fortunate as to be able to listen to buyers were actually offered 60s. per ton for No. 3. It is long since the iron trade of the North of England was in such a flourishing condition as it is now. Orders for next year are being freely booked at 57s. and 58s. per ton for No. 3, and the other qualities in proportion. Some people believe that the rates paid at present are exceptional, and that as soon as the navigation season closes there will be a fall in prices. The more general opinion, however, is that the enormous demand really exceeds the power of supply, great as it is, and that after Christmas prices will be higher than they are now. Certainly makers are being threatened for non-delivery, and are heavily sold forward.

The Finished Iron Trade.—There is more reason than ever to believe that the Cleveland rail trade next year will be one of the best that busy district has experienced for a long time. Last week we pointed out the requirements of different countries where railway extension is being carried on with great energy. It must not be forgotten that the home demands will be heavy on account of the several tramways, in addition to renewals in different parts of Great Britain. All the other branches of the finished iron trade are in a satisfactory condition.

The Lustrum Iron Works.—We learn that Mr. Joseph Dodds, M.P. for Stockton, has purchased the Lustrum Iron Works, Stockton. That gentleman, we understand, is interested in several iron works in Stockton and Middlesbrough, all of which are in a flourishing state. It is his intention to enlarge very considerably the works he has just purchased.

The Nine Hours' Movement at Middlesbrough.—On Saturday next the notices of something like 1700 engineers, employed by different firms at Middlesbrough, expire, and they will cease work if the masters do not before that time make some arrangement with them respecting the nine hours' system. The men ask for the nine hours' system on the conditions granted at Sunderland, viz., that each day's work stands by itself, and all overtime to be paid for. The masters have conceded the nine hours on the Newcastle terms, viz., that fifty-four hours per week must be worked before overtime can be paid for. It is to be hoped that a settlement of the difference will be arranged without the stoppage of work.

The Tees Conservancy.—The annual meeting of the Tees Conservancy Board was held at Stockton on Monday, when the able chairman, Mr. Isaac Wilson, of Middlesbrough, was re-elected.

The Iron and Steel Institute.—The next general meeting of the Iron and Steel Institute, whose head-quarters are at Middlesbrough, will be held on the 19th, 20th, and 21st March next, in London. Invitations are to be sent to Continental and American ironmasters, and as this institution has taken such an important position there is little doubt that many gentlemen from a great distance will attend the meeting.

NOTES FROM THE SOUTH-WEST.

Great Western Railway.—Without any prior agitation on their part, the engineers and others employed in the locomotive departments of the Swindon and Paddington stations of the Great Western Railway have received an intimation from the directors that from January 1, 1872, they will only be required to work 54 hours per week.

Trade at Swansea.—The mills and forges in the Swansea district are still doing well, considering the season of the year. There are good orders on the books of the principal works.

A Central Station at Swansea.—At the monthly meeting of the Swansea Harbour Trust on Monday, a rather important letter was read from Mr. L. L. Dillwyn, M.P., on behalf of the Great Western Railway Company. Mr. Dillwyn wrote:—"You are aware that the Great Western Company are about to convert their line in South Wales from broad to narrow gauge. This circumstance, combined with the altered relative positions of the Llanelly and London and North-Western Companies, render it probable that new arrangements will have to be entered into for providing a central station in Swansea. The time, however, has not arrived when such arrangements can be carried out; and pending this, we do not feel ourselves in a position to do anything respecting the Swansea station in the ensuing session of Parliament."

Sewage at East Dean.—A committee has been formed among the principal inhabitants of that portion of the parish of Flaxley adjoining East Dean for the purpose of carrying out a system of sewerage. Mr. F. Flewett, of Newnham, has been consulted upon the subject, and has prepared plans to secure the object in view.

Carmarthenshire Mineral Railway.—A meeting in support of this project was held at Carmarthen on Saturday. It was stated that the capital sought to be raised by shares was 160,000*l.* The length of the proposed line is 27 miles, and it was stated that, if carried out, it would have one terminus at Carmarthen and another at Pontardulais, with lateral branches entering into the heart of the lime and mineral districts, which it would traverse. It has been stated that the length of the line will be 27 miles, but it should be explained that of this mileage the main line will contribute only 19 miles, while the branches will make up the remaining 8 miles. The total cost of the line is estimated at 6000*l.* per mile, including rolling stock.

Pembroke Dock.—Her Majesty's steam-frigate Buzzard has arrived at Pembroke Dock from Plymouth, having on

board a party of seamen, &c., who will navigate the Decoy, composite gunboat, recently launched at Pembroke Dock-yard, round to Plymouth, where she will be commissioned. The Buzzard will also accompany the Decoy to her destination. The launch of a sister gunboat, named the Merlin, will take place on the 24th inst. Another gunboat of the same class, the Mosquito, is in a forward state, and will be shortly launched.

Gloucester and Berkeley Canal Company.—At the half-yearly meeting of this company, it was agreed that a quay-wall should be substituted in the new basin for the sloping banks first proposed. This alteration in the plans will involve an additional outlay of 13,000*l.* At the close of the meeting, several of the shareholders had a discussion on the Sevenbridge railway scheme.

The Rhondda Valley.—An important winning at the Bodringallt colliery, in the Rhondda Valley, has been successfully effected. The seam of coal, which thus seems likely to be brought into working after a large outlay, is identical with the Upper Four-feet Vein, which has been successfully worked at the Ferndale colliery and in the Aberdare Valley.

Mr. Crawshay Bailey.—Mr. Crawshay Bailey, the founder of the Nantyglo Iron Works (who is now an octogenarian), commenced business at Nantyglo 61 years since, and since then he has expended 33,000,000*l.* in wages. The business at Nantyglo has been recently transferred to a limited liability company.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—A week ago 65s. 6d. cash, and 65s. 10d. one month were accepted for Scotch pig iron, but since then there has been a large rise in price. On Thursday there was an advance of one shilling per ton, and on Friday the advance was about as great. Monday's market was very excited, owing in some measure to the failure of a well-known member of the Glasgow "Iron Ring." Mr. Thomas Thorburn, whose liabilities are estimated at from 15,000*l.* to 20,000*l.* A large business was done on Monday at prices varying from 68s. up to 69s. The market was irregular yesterday. At the opening prices ran down to 68s. 1½d. cash, but they afterwards rallied, and at the close 69s. cash and 69s. 4½d. one month were paid. To-day's market has been flat, no business being reported; sellers at 68s. 4½d. cash, buyers 1½d. per ton less. Last week's shipments of Scotch pig iron were, foreign, 13,298 tons; coastwise, 5338 tons; total, 18,636 tons; same week last year 10,357 tons; increase 8279 tons. The total increase since the 27th of December, 1870, up to last Saturday was 179,888 tons. Of course the special brands have gone up considerably of late in sympathy with the advance of price in G. M. B. iron. Coltness No. 1 was quoted at 80s., and Gartsherrie No. 1 at 78s.

Howatson's Patent Furnace.—This furnace, which, it may be remembered, excited a great deal of interest among the members of the Iron and Steel Institute on the occasion of their visit to the Earl of Dudley's Round Oak Iron Works, is now being introduced into Scotland, and it is also making much progress in England. Messrs. Dübs and Co., of the Glasgow Locomotive Works, have just had one of their forging furnaces altered in accordance with Mr. Howatson's patent. The Parkhead Forge Company have adopted it as a heating furnace; several of the Coatbridge ironmasters have "gone in" for it; and Mr. Howatson is putting up 30 of his furnaces for Mr. Colville at Motherwell.

New Ironwork Contracts.—Messrs. Laidlaw and Sons, gas engineers, Glasgow, are the successful contractors for the supply of a complete plant for the lighting of Yokohama, the principal commercial centre of Japan; and Messrs. George Bennie and Co., the well-known mineral oil engineers, also of Glasgow, have been instructed to supply a large amount of plant for the production and refining of mineral oil in Russia, the mineral to be employed being a rich shale, somewhat resembling the famous Boghead coal, or Torbane hill mineral.

Commencement of the Tramway Traffic in Edinburgh.—The passenger traffic on the Edinburgh and Leith tramways was commenced last week. There were in all ten cars run on the opening day, and the greatest number of runs made was twelve. About 12,000 persons took advantage of the cars, but, owing to the novelty of this kind of street locomotion, the number of passengers was probably much above the average traffic that may be expected when the novelty has worn off. As the conductors and drivers were alike new to the work, it was expected that a few hitches might occur, but there was nothing of a serious character. An additional number of cars will doubtless soon be put on. Owing to the great demand for accommodation on Saturday, an additional car was put on, and on that day there were about 12,000 passengers, making about 65,000 for the whole week.

The New Dock for Berwick-upon-Tweed.—Plans of the new dock to be erected by the Berwick Harbour Commissioners on the south (Tweedmouth) side of the river have been prepared by Messrs. Stevenson, C.E., Edinburgh, and approved of by the Committee of the Harbour Commissioners. The new dock will cover three acres of land and water, and is expected to accommodate eighteen large vessels. The total cost is estimated at fully 40,000*l.* Parliamentary powers will require to be obtained before the dock can be built.

Royal Scottish Society of Arts.—The annual general meeting of this Society was held in Edinburgh on Monday night—Mr. John Paterson, vice-president, in the chair. An address, prepared by Mr. R. W. Thomson, C.E., the president of the Society, was read in his absence through illness. It was devoted to the future rather than to a survey of the past, and suggested many points of interest in reference to the patent laws, the disposal of the sewage of large towns, the water supply and its separation into two qualities, the employment of steam in agriculture, &c. The report of the Prize Committee awarding the prizes for the session 1870-71 was afterwards read. It stated that the special thanks of the Society were due to Dr. Stevenson Macadam for his "Discourse on Technical Chemistry," and to Professor Archer for his "Address on Recent Progress in Inventions." The committee had also awarded the following prizes: 1. To James Mackenzie, Manager's Department of the North British Railway Company, for his "Description of a New Steel-yard Indicator," a Keith prize, value ten sovereigns. 2. To John Reid, Manager of the Edinburgh and Leith Gas Company, for his paper on "Water Meters as in use by Water Companies," with design for simplifying and cheapening them, a Keith prize, value ten sovereigns. 3. To Stevenson Macadam, Ph. D., F.R.S.E., M.C.S., for his paper on the "Distillation of Gas from Coal in Short-Time Charges, as compared with Long-Time Charges," the Hepburn prize, value seven sovereigns. 4. To Alexander Leslie, C.E. Assoc. Inst. C.E., for his paper on "Rainfall and Evaporation in Relation to Water Supply," the Society's silver medal, value seven sovereigns. 5. To Robert William Thomson, C.E., F.R.S.E., for his "Description of a New Method of Fixing Tubes in Vertical Steam Boilers," the Society's silver medal, value five sovereigns. 6. To Robert Louis Stevenson, C.E., for his "Notice of a New Form of Intermittent Light for Lighthouses," the Society's silver medal, value three sovereigns. 7. To John St. Clair, teacher of music, for his "Description of a New System of Embossed Music for the Blind," the Society's silver medal, value three sovereigns. 8. To James Denham, cabinetmaker, for his "Description of a New Hinge for the Doors of Writers' Pigeon-Holes," the Society's silver medal.

Edinburgh Evening Lectures to the Industrial Classes.—The director of the Museum of Science and Art, Edinburgh, has arranged for the delivery of six courses of scientific lectures to the industrial classes of Edinburgh during the ensuing winter. Each course will embrace six lectures. Dr. R. M. Ferguson, and Professors Tait, A. Crum Brown, and Geikie will take part in them, their respective subjects being: Sound, Electricity, Chemistry of Fire and Fuel, and the Elements of Physical Geography.

FOREIGN AND COLONIAL NOTES.

An American Tunnel.—A new tunnel at Hartford for the Hartford and New Haven Railroad is nearly completed. The enlargement of the old tunnel was carried on through an exceedingly troublesome strata of quicksand and clay, which had a tendency to cave in, and thus seriously impede the operation of excavating and pile-driving, which was carried on at the same time. The tunnel passes under two busy streets, one having a horse railroad track, and both having gas pipes, aqueduct pipes, &c., all of which had to be moved and removed in a manner not to create inconvenience to the public. The work was carried out under the immediate supervision of Mr. E. M. Read, superintendent of the Hartford and New Haven Railroad.

Northern Railway of Canada—This company has completed a new grain elevator at Collingwood. The building is located on a new and substantial dock 100 ft. wide and 600 ft. long, surmounted with crib-work, and filled in with solid stone and gravel, thus forming a perfectly fireproof wharf. The outside dimensions of the building are 60 ft. by 100 ft., and the total height from the level of the dock to the top of the roof is 135 ft. The engine-house, 30 ft. by 40 ft., of stone and brick, with iron doors, and roof and stone floor, is isolated from the main building. The engine (which is of 50 horse power) and the other machinery were constructed by Messrs. W. Hamilton and Son, of Toronto; and the boiler and iron tanks by Mr. Neil Currie, of Toronto.

Turkish Tramways.—The main way of the tramway line between Taheragon and Ortakeui has been completed, and the rails will be placed in a few days, when the whole line will be open between the latter village and Karakeui.

Illinois and St. Louis Bridge.—This great bridge is progressing rapidly. The concrete or foundation for the east pier, a small one on the Illinois side of the river, has been laid, and on the completion of the pier the bridge company will have no further use for the air pumps, &c., which it has employed. The masonry, of which there will be about 103,000 cubic yards, is about two-thirds completed, and the superstructure has been already commenced. The cast-iron plates at the piers have been placed and prepared for the reception of the steel tubes forming the spans. The bridge will be completed in about a year.

Russian Railways.—Russian railways continue to make progress. The first working train has run along the Yaroslavl and Vologda line as far as Danilov.' A broad gauge horse railway from Samara to Uralsk, 161 miles in length, is about to be commenced. A cross line is projected from Mitau to Tilsit. The Kiev and Brest line continues to progress, and that from Voronej to Grouskevka may be said to be all but completed. A company is being formed in St. Petersburg for the construction of a number of small branch lines in the central and southern provinces of Russia in order to facilitate the transport of manufactured goods. A concession has been granted for the construction of a railway through Western Finland, between Tammafors, Tavastheurs, and Abo.

Ontario Wood Pavement Company.—This company has established some rather extensive works where the lumber for street pavement is cut into blocks, and afterwards carbolised. The wood is thoroughly impregnated with carbolic acid, and it is alleged that it does not then decay.

American Coast Surveys—Mr. Benjamin Pierce, in a report on the operations of the United States coast survey during the past year, states that surveys have been proceeding upon Lake Champlain, the Hudson river, Long Island Sound, and New York and Newark Bays. Extensive observations have been made of the physical changes in New York harbour and also of the tides. A surveying party has been sent to make observations in Alaska and the Aleutian Islands, but no account of their operations has yet been received. Calculations have been made during the past year which fix the longitude of several places in the interior of the United States—amongst them Omaha, Salt Lake City, and San Francisco—while computations are in progress for ascertaining transatlantic longitudes which depend upon observations made last year at Brest and Duxbury.

Docks at Sebastopol.—The Russian Government is said to have concluded the purchase of docks constructed by the Russian Steam Navigation Company, at Sebastopol.

Queensland Telegraphy.—Mr. W. J. Cracknell, superintended of telegraphs in Queensland, left Brisbane for Cardwell, August 10, for the purpose of making a personal inspection of the telegraph line from that town right through to the Gulf of Carpentaria. Mr. Cracknell was expected to be absent from Brisbane about eight weeks.

A Curious Calculation.—It is estimated that 150,000 acres of the best timber in the United States are now absorbed annually in supplying the demand for railway ties alone.

The Darien Ship Canal.—Commander Selfridge claims to have discovered a practicable route for a Darien ship canal. It starts from the Gulf of Darien on the Atlantic slope, proceeds up the Atrato river to the mouth of the Napipi, and thence runs to the Pacific Ocean at Capica Bay.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

New Blast Furnaces at Staveley.—The Staveley Coal and Iron Company, Staveley, near Chesterfield, has this week blown in another blast furnace. The company have now six furnaces at work, which enable them to turn out an immense quantity of iron.

New Railway Station for York.—In two or three years hence York will possess a station which will, in all probability, be the largest in England. The present accommodation for the through passengers, to say nothing of the local and other North-Eastern traffic at York, is very inferior, and entirely inadequate to properly work the constantly increasing passenger traffic. Two years ago the North-Eastern sought and obtained parliamentary powers to purchase the house and other property on the intended site for the new station. The plans were approved by their Board last week. The present station is terminal, and consequently a great deal of shunting, necessitating a number of points, &c., has to be done in order to get trains in and out. The new one will have through platforms, the covered portion alone of which will be 1350 ft. in length, or nearly a quarter of a mile. It will be of a crescent form, and the site is fixed at about 250 yards further from the Ouse bridge than the present structure. The station alone, it is estimated, will cost about 200,000*l.* A new street will be made to it from Queen-street. The present coal and lime depôts are to be abolished, and a monster hotel erected where they now stand. This hotel will be finely situated, and will command an excellent view of the city and suburbs. When completed the station and hotel should enhance the popularity of the east coast route for through travelling from and to Scotland, as compared with the west coast route.

Proposed New Branch Railway at York.—It is stated that the North-Eastern directorate contemplate the construction of a loop, or connecting, line from their York and Scarborough branch, near the Cricket Ground, at York, to the Foss Island, where they propose to erect a mineral, goods, &c., station. The branch will be about a mile in length, and will be made in deference to a memorial presented by the residents on the east side of the city. The North-Eastern directors will expend 30,000*l.* on the line, and stipulate that any cost beyond that sum shall be borne by the city. They will charge special rates for all traffic over the branch.

Coal Traffic—South Yorkshire and Derbyshire to London.—Despite the fact that the rate from South Yorkshire to London has been advanced during October by the Great Northern and Midland sevenpence and eightpence respectively, there is an increase of a very considerable amount during that month. Of Silkstone coal the Great Northern took 20,000 tons, being an increase of over 8000 tons. Of the Barnsley thick coal a total tonnage of 23,078; increase, 5509 tons. From Derbyshire 106,121 tons went to the metropolis in October; of this quantity Clay Cross alone contributed 34,778 tons; Langley, 14,770 tons, and other collieries in smaller quantities, the aggregate showing an increase over September of 17,687 tons.

The Nine Hours' Movement at Sheffield.—The nine hours' system may now be said to have become general at Sheffield, and throughout the district. Each day the names of the firms who concede it are recorded, and the list is much too bulky for my enumeration. The men held their congratulatory meeting last Wednesday, and delegates from Newcastle and Manchester were present. The speakers took occasion to protest against systematic overtime.

Connecting Line of Railway near Eckington.—The Midland and Manchester, Sheffield and Lincolnshire Railways will apply for parliamentary powers during the ensuing session, for the construction of a branch connecting line between their respective main lines near Eckington, Derbyshire. The line will leave the Masborough and Chesterfield section of the Midland Railway near Eckington, near the bridge carrying over that railway the road from Beighton to Swallownest, and terminating by a junction with the sidings of the Birley Vale branch of the Manchester, Sheffield, and Lincolnshire Railway at Normanton Spring Wood. That branch of the latter company joins their main line at Woodhouse junction, about six miles from Sheffield. Should the amalgamation of these two companies be carried out this line will be without doubt very useful for the interchange of certain descriptions of traffic.

RECENT PATENTS.

The following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them at the annexed prices, from the Great Seal Patent Office, Chancery-lane:

(No. 3135, 10d.) Thomas Hydes and John Emil Bennett, of Sheffield, patent making the bridges of furnaces of double walls levelled at the top so as to form a hopper, which will receive any fuel or ashes which would otherwise rest on the tops of the walls. The space between the walls is fitted with a door for discharging the fuel or ashes thus collected. The patent also includes making the solid front of a furnace-door move away from the perforated back or box portion in such a manner as to regulate the quantity of air admitted to the furnace and cause it to be heated before entering the latter.

(No. 3137, 1s. 2d.) Robert Lees, of Hyde, patents increasing the heating surface of boilers by fitting the flues and fireboxes with spherical "water pockets," each of which is attached to the sides or crown of the flues or firebox by means of a short neck, and is fitted with an internal circulating tube. We fear that notwithstanding the tube just mentioned the water pockets would become coated with incrustation and burn out.

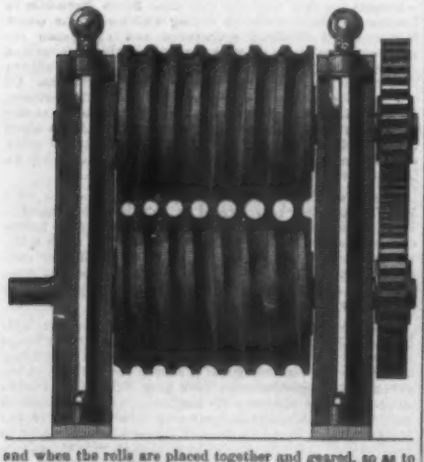
(No. 3139, 4d.) Henry Larkin, of Theydon Gernon, Andrew Leighton, of 33, Chapel Walk, Liverpool, and William White, of 30, Thurlow-road, Hampstead, patent obtaining iron, steel, and oxide of iron free from impurities by dissolving crude iron, or any suitable ore containing the metal, in hydrochloric acid for the purpose of converting the iron into ferrous chloride. This latter product is to be subsequently purified by crystallisation, and then decomposed, the chlorine set free being reconverted into hydrochloric acid for treating a further quantity of the crude material. The impure hydrogen set free when the metal is being dissolved is also to be collected and utilised.

(No. 3143, 9d.) George Haseltine, of Southampton-buildings, patents, as the agent of Frederick Hoeltge, of Covington, U.S., forming the elbows of sheet metal pipes by corrugating the metal upon the concave side, these corrugations having their greatest depth at the inner side of the curved elbow, and gradually diminishing as they extend round the pipe, until about half way round they disappear altogether.

(No. 3144, 1s. 6d.) Richard Montgomery, of New York, patents making girders or beams of wrought iron or steel with deep longitudinal corrugations, one of the sections proposed being shown by the full lines in the annexed

sketch. It is also proposed to combine with these girders caps or rails of the section shown by the dotted lines, these rails being secured by transverse bolts at intervals. Particular methods of building up the piles for the beams above referred to, and arrangements for rolling, are included in the patent.

(No. 3156, 10d.) Henry Kesterton, of 9, Stratford-road, Birmingham, patents an ingenious arrangement of rolls for rolling taper tubes or rods. According to these plans there is employed a pair of rolls, each roll having a spiral groove of variable depth, and of half round section, turned on it. The groove in one roll is a right handed, and that in the other a left-handed spiral, as shown in the subjoined sketch,



and when the rolls are placed together and geared, so as to revolve in union, the grooves form a series of eyes which, as the rolls revolve, appear to move laterally, and gradually decrease in size. Thus, if a bar or tapered strip of iron, bent so as to approximately form a tube, be introduced between the rolls at that end where the grooves are largest and deepest, it will be gradually shifted towards the other end of the rolls as it passes between the latter, and will thus be rolled tapered.

(No. 3160, 8d.) Thomas John Marshall, of Bishopsgate-street Without, patents cleansing the continuous felts of paper machines whilst in motion, by passing them over a revolving perforated cylindrical vacuum roll, having hollow trunnions, and an internal vacuum box or trough connected to pumps, so that by the action of the latter all the particles which adhere to the felt may be drawn through the perforations in the cylinder into the vacuum box.

(No. 3163, 1k.) John Weems and William Weems, of Johnstone, patent arrangements for drying yarns, woven fabrics, fibrous materials, &c. In cases where a fan is used to force air through tubes surrounded by steam, Messrs. Weems propose to fit into the ends of the tubes at which the air enters thin plate diaphragms of a spiral form, so as to give to the air a swirling motion during its passage through the tubes. The patent also includes arrangements for drying and tentering woven fabrics, which we could not describe briefly, and also arrangements for carrying yarns or fibrous materials gradually through a drying chamber.

(No. 3169, 8d.) Henry Young Darracott Scott, of Ealing, patents methods of treating sewage matters. General Scott proposes to deal with the sewage matter in detail, applying the chemicals employed for separating it from its impurities at various points distributed over the whole district from which the sewage is drawn. The patent under notice includes arrangements for supplying the chemicals to the sewage automatically, and the patentee also claims the employment for treating the sewage, of the compound resulting from the calcination under oxidising influences of the refuse taken from the lime purifiers of gas works.

(No. 3174, 1s. 2d.) William Hargreaves and William Inglis, of Bolton, patent an arrangement of blowing engines, in which a pair of vertical blowing cylinders are placed a short distance apart, with valve chambers of a peculiar form between them. Each valve chamber is of a kind of ⊃ shape in section, the larger end of the ⊃ being next the cylinder, and the discharge and inlet valves being fitted to the upper and lower sides respectively. The covers are arranged so that the valves are readily accessible. The patent also includes a form of valve for blowing engines, these valves consisting of cylinders covered with vulcanised india-rubber, disposed with their axes horizontal, so as to close longitudinal rectangular slots in seats. In some cases the seats are made concave, so as to fit the cylinders and give large bearing surface.

(No. 3176, 1s. 4d.) George Holcroft and William Nathan Dack, of Manchester, patent connecting to an air pump the condenser of an engine in which the vacuum is obtained by an ejector. The patent also includes the application of two or more ejectors to one engine or condensing chamber, a mode of casting one cylinder of a compound engine to the stays which connect it with the other cylinder, and arrangements of valve and cut-off gear, which we could not describe briefly.

(No. 3186, 1s. 2d.) Edward Rush Turner, of St. Peter's Iron Works, Ipswich, patents the arrangements of piston valves and self-controlling expansion gear for steam engines, illustrated and described by us on page 464 of our tenth volume.

(No. 3203, 1s. 6d.) Henry Arthur Dibbin, of Stoke-on-Trent, patents arrangements of electric railway signalling apparatus, actuated by passing trains, and intended to convey to the drivers of such trains information as to whether or not the line is clear for a certain distance ahead. Information that the line is not clear is afforded by the explosion of detonating signals. We could not describe the details of these plans briefly.

(No. 3205, 1s. 2d.) William Nelson Hutchinson, of Wellesbourne, near Bideford, patents some impracticable plans for attaching caps or cover plates to the wearing surfaces of railway rails.

(No. 3206, 8d.) James Howard and Edward Tenney Bousfield, of Bedford, patent a mode of applying india-rubber or other elastic washers for the purpose of making water or steam-tight joints. According to these plans the elastic washers are coated with thin sheet metal, the covering being such as to protect the india-rubber, and at the same time not so thick as to interfere with its elasticity. The washer thus protected is placed in a recess in one of the joint surfaces, a rib on the outer surface bearing against it.

(No. 3210, 1s. 10d.) William Mort, of 155, Fenchurch-street, patents, as the agent of Eugène Dominique Nicolle and Thomas Sutcliffe Mort, of Sydney, an arrangement of cooling and freezing machine, in which ammoniacal gas is used as the refrigerating medium. We could not describe these plans within the space available here.

(No. 3211, 8d.) William Chamberlin, of Brighton, patents an apparatus for placing fog signals on the rails. In this apparatus—which is capable of being worked from a distance by a cord or wire—the fog signals are contained in a hopper from the lower part of which the signals are taken in succession, and thrust forward on to the rails by means of a sliding bar. A stem or finger formed on each signal enables them to be withdrawn from the rail when required, special arrangements being provided for collecting the signals thus withdrawn without being exploded.

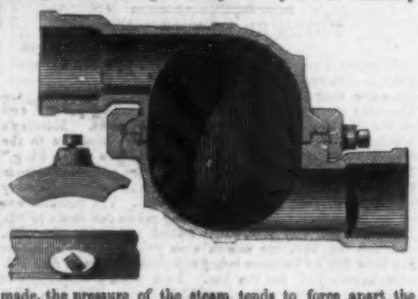
No. 3228, 2s. 4d.) William Lloyd Wise, of Chandos Chambers, Adelphi, patents, as the agent of Wilhelm Klinkerfues, of the Royal Observatory of Gottingen, Hanover, some ingenious arrangements for lighting gas by electricity. We cannot describe these plans fully here, but we may mention that in some of them advantage is taken of the catalytic power possessed by solid platinum when slightly heated by the passage of an electric current. We hope at some future time to have more to say concerning Doctor Klinkerfues's plans.

(No. 3241, 6s. 4d.) John Boyns, of St. Just, Cornwall, patents machinery for dressing, crushing, and amalgamating metallic ores. This is a very voluminous specification, and it is, therefore, impossible for us to do more than direct attention to it here.

(No. 3242, 8d.) John Hosking and John Morrison, of Gateshead, patent making the shells and fines of boilers of corrugated plates, the corrugations running circumferentially. We fear that the longitudinal joints of such boilers would be difficult to make tight, otherwise the corrugations might serve a useful purpose, particularly in the case of internal fines, where they would give increased power of resisting external pressure, and afford a certain amount of longitudinal elasticity.

STEAM PIPE JOINT.

We subjoin an engraving showing a neat form of flexible joint for steam pipes, which has been designed by Messrs. Wöhrmann and Son, of Mülenhof, near Riga, Russia, and which has been successfully employed by them for the pipes of steam pile-driving machines at works for the port of Mühlgraben, near Riga. In spherical joints as ordinarily



made, the pressure of the steam tends to force apart the surfaces which fit together, and which form the steam-tight joint; but in the arrangement we illustrate, this action is reversed, the pressure of the steam tending to force the joint surfaces together. Our engraving, which is drawn one-fifth full size, shows the joint as applied to a 2 in. pipe, and it explains the construction so clearly that a further description will be unnecessary. The joint is stated to answer well, and there are no doubt many situations in which it may be usefully applied.

COMPOUND *v.* SINGLE CYLINDER ENGINES.

To the Editor of Engineering.

Sir,—In your paper of this week I see a letter from Mr. R. H. Tweddell, of Sunderland, the statements contained in which call for some comment. In the first place, Mr. Tweddell states that the marine engine builders on the Tyne, Wear, and Tees, surpass their brethren of the Clyde, Thames, and Mersey. I cannot call to mind any cases in which the Tyne, Wear, or Tees builders have produced finer, lighter, or more economical engines than Penn's in the Inconstant and Hercules, Elder's in the Tenedos, Rennie's in the Briton, Maudslay's in the King William. One firm who I presume Mr. Tweddell includes among the Tyne, Wear, and Tees engineers (Messrs. Richardson), have obtained their best results from the very class of engine which he so much objects to, viz., the modern compound engine with cranks set at right angles.

Mr. Tweddell puts simplicity and fewness of parts before all; from this I should infer that he considered that a compound engine must of necessity have more complication than an ordinary engine. I much doubt if the compound engines of Napier in the Queen of the Thames, Elder's in the Tenedos, or Messrs. Richardson's new compound engines are greatly if at all more complicated than ordinary engines of the same power. Mr. Tweddell, when he speaks of the loss of pressure between the cylinders, entirely ignores the saving of the low-pressure cylinder by its acting as a heat trap, which action was so ably pointed out by you some time back in your articles on "Compound Engines." Mr. Tweddell in advocating a "high pressure surface condensing engine," does not explain how it is that when made by the same builders and designers, the compound engine has always surpassed this very class of engine in its performance, nor why it is that no firm who have once commenced making compound engines ever returned to the old type. Further on, Mr. Tweddell suggests a "modification of a lever engine with a 7 ft. or 8 ft. stroke." On examination of this suggestion, it will be found that an engine of 8 ft. stroke running at (say) 600 ft. per minute, will make 37½ revolutions per minute, a speed which would require gearing to rotate the screw shaft at sufficient velocity; and gearing, as Mr. Tweddell truly remarks, "is objectionable." Mr. Tweddell regards the locomotive as the ideal that all marine engineers should work up to. If he will take into consideration that one is a condensing engine working on an average at 50 lb. on the inch, and also the relative consumption of fuel, he might find that marine engineers have reached the "proud position" alluded to.

I do not wish to decry high speed, for in that and great pressure seem to lie the future of marine engineering, but I cannot agree with Mr. Tweddell that the screw will not perform well at much higher speeds than are now used.

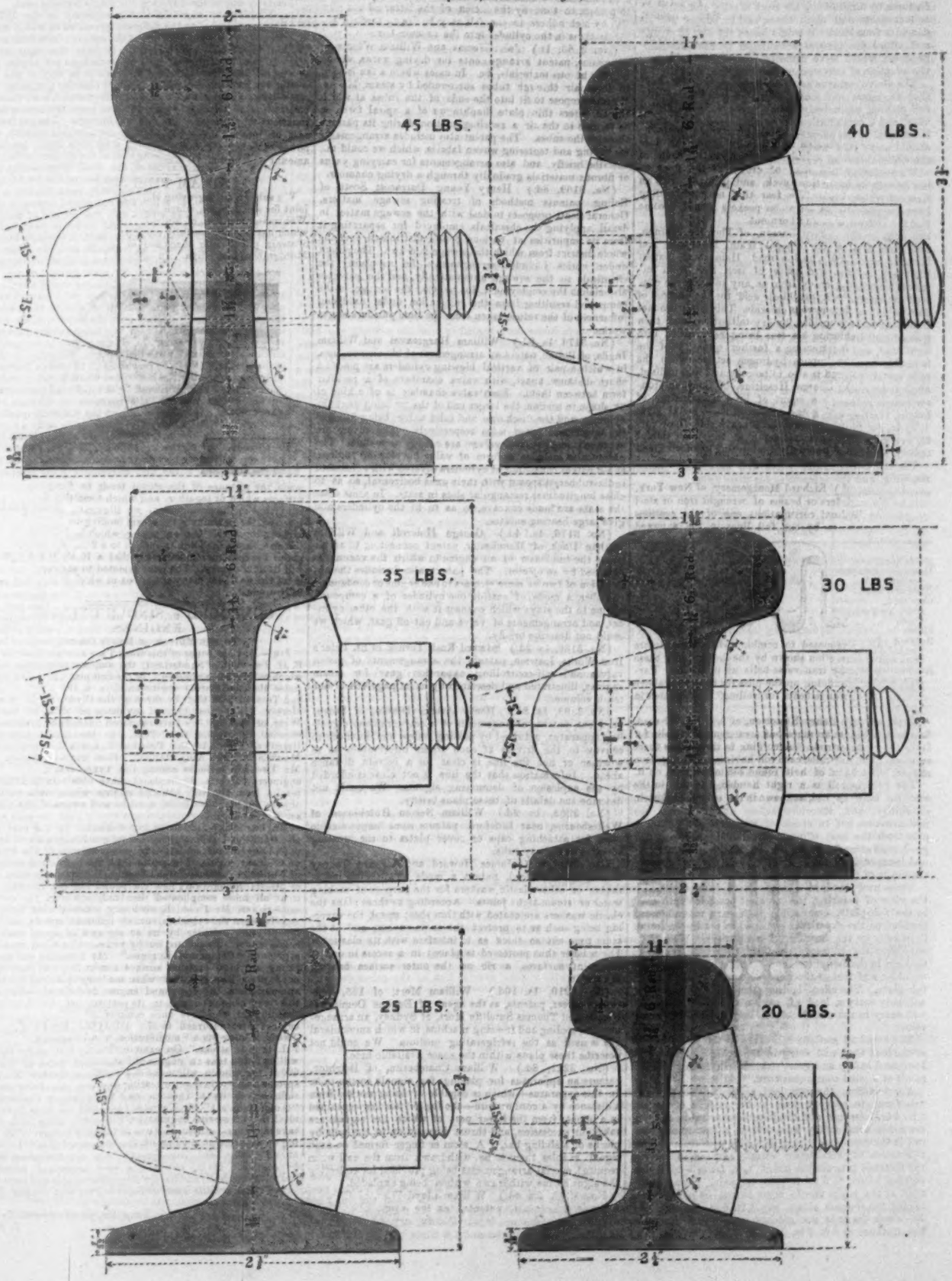
Yours truly,

London, November 11, 1871. Compound Engine.

STANDARD RAIL SECTIONS FOR LIGHT RAILWAYS.

DESIGNED BY MR. C. P. SANDBERG, ENGINEER, LONDON.

(*For Description, see next Page.*)



LIGHT PERMANENT WAY.

When Mr. Bessemer, as President of the Iron and Steel Institute, delivered his inaugural address in London, on the 28th of March, 1871, he said: "The adoption of a standard rail would afford great facilities to the manufacturer by diminishing his stock of rolls, and allowing him to manufacture in slack times, and to supply any sudden demands from stock. It would lessen the cost of production, and afford the general advantages to the consumer and producer, which have hitherto resulted in all cases from the adoption of universal or standard measures."

The above remarks are the more important from the fact that engineers and manufacturers regard the subject of rail-making exclusively from their own special points of view, and a combination of the requirements of both parties is essential to the adoption of standard rail sections, which should unite that which the engineer desires, and what the rail-makers can practically execute.

We published, some two years ago, standard sections for heavy rails designed by Mr. C. P. Sandberg, the medium sizes of which, viz., from 50 to 60 lb. per yard, have now been extensively adopted, particularly in America, and we find the sections above specified being rolled at nearly all the rail mills in this country. There is reason to believe they will make a good and durable road when carefully manufactured, and makers are getting reconciled to them. Mr. Sandberg has now designed standard sections for light rails which we illustrate on the preceding page, and will now proceed to describe. We note that the principle of making the base equal to the height of the rail, as adopted by Mr. Sandberg for his heavy sections, is here modified on the ground that less speed and lighter traffic is expected on a light road, and that increased stiffness by increase of height is in this case more necessary than stability; thus these rails are all $\frac{1}{4}$ in. higher than wide in the base; the fishing angle is increased to 15° for easy rolling, and the weight of sections is reduced 5 lb. for every $\frac{1}{4}$ in. reduced width and height, starting with $3\frac{1}{4}$ in. $\times 3\frac{1}{4}$ in. for 45 lb. down to $2\frac{1}{4}$ in. $\times 2\frac{1}{4}$ in. for 20 lb. Intermediate sections graduating $\frac{1}{4}$ in. for every $2\frac{1}{2}$ lb. per yard can easily be designed on the same principle.

The following Table gives the details of punching, notching, and the accessories for these rails:

	Rails. 45 and 40 lb. per yard.	Rails. 35 and 30 lb. per yard.	Rails. 25 and 20 lb. per yard.
	in.	in.	in.
Holes in rail oval ...	$1\frac{1}{4} \times \frac{3}{4}$	$1 \times \frac{3}{4}$	$\frac{7}{8} \times \frac{3}{4}$
Holes in fish-plate pear-shaped	$\frac{3}{4}$ diam.	$\frac{3}{4}$ diam.	$\frac{3}{4}$ diam.
Bolts and nuts:			
Cup-head square nuts, pear-shaped necks	$\frac{3}{4}$ diam.	$\frac{3}{4}$ diam.	$\frac{3}{4}$ diam.
Spikes	$4\frac{1}{2}$ long $\times \frac{1}{2}$ sq.	$4\frac{1}{2}$ long $\times \frac{7}{16}$ sq.	$4\frac{1}{2}$ long $\times \frac{3}{8}$ sq.
Notches for suspended joints 9 in. from end of rail ...	$\frac{3}{4} \times \frac{1}{2}$	$\frac{3}{4} \times \frac{1}{2}$	$\frac{3}{4} \times \frac{1}{2}$
Notches where joint lays on sleeper 2 in. from end of rail ...	"	"	"

There are two holes at each end of rail. The centre of first hole is $1\frac{1}{2}$ in. from the end, and that of the second $3\frac{1}{2}$ in. from the centre of the first. This is invariable in all the sections. The fish-plates are all 18 in. long, with four pear-shaped holes $3\frac{1}{2}$ in. between centres in each plate.

The principal advantages of using properly-designed sections may be summed up thus: cheapness, increased durability, and, therefore, safety and decreased cost of maintenance, not to speak of the saving in cost of transport from the seat of manufacture. In order to secure a good road strong joints are indispensable. With the simple and inexpensive fish ordinarily used, the form of the rail section is of the greatest importance.

These new standard sections have been designed with the view of securing the greatest possible depth and grip in the fish-plate, compatible with easy manufacture, and founded on the experience obtained in the inspection of the light rails for the Scandinavian railways. With the ordinary pear-shaped form of rail head, the shoulders offer no resistance to the fish-plates, and the difference of angles in the shoulder and foot of the rail will not admit of a reversible fish-plate. The effect is that the joints of these sections will only carry a load of, say, one-third of what the rail will carry in the middle of its length for the same deflection.

The standard sections will carry at the joints two-thirds of the load they will carry in the middle of their length. Increased safety and great economy in rolling stock is the result of a good continuous road.

For instance, the standard section, 40 lb. per yard, is calculated to carry 9 tons in the middle of its length, 2 ft. 6 in. bearings, and the joint 6 tons, but as the sleepers are not so firm as the supports in a testing machine, the rail in the road should only be loaded with from one-half to two-thirds of this latter stress, varying according to the distance between the axles, say, from 3 to 4 tons per driving wheel, or 6 to 8 tons per axle. The weakness of road at the joints can to some extent be compensated by laying the sleepers closer, say, 1 ft. 6 in. between centres, for which the rails are notched, and gradually increasing the distance to 2 ft. 9 in. in the middle. Where the joint is supported the notches are 2 in. from end of rail requiring a stouter sleeper, but on the Swedish and Norwegian railways the suspended joint is preferred. These sections seem to us as worthy of adoption as the heavy ones, and as we have every confidence in the future of light railways, and have dwelt considerably upon the subject of rolling stock adapted to them, we are glad to supplement our remarks by treating of permanent way also. As saving of expense is the chief consideration in the adoption of light lines, in order to make them pay themselves as well as feed the main lines, rails of lighter section are required by engineers, but at present light rails are manufactured in the ordinary rolling mills for heavy ones, which causes loss to both master and men, and lead the former to look upon orders for light rails with somewhat of dissatisfaction. It would manifestly be a great improvement if mills were established for the sole manufacture of light rails, and we consider this would form an additional source of business in our iron and steel trade. We believe that the reason there are at present no such mills established for the manufacture of light rails is materially owing to the opinion makers hold that a sufficient extra price is not paid for them to cover the extra labour and cost of production, when, for instance, ten rails are required per ton instead of five. The excess of demand over supply now existing will tend to rectify this and insure them an adequate price, and instead of makers, as now, only rolling light rails in their ordinary mills at slack times, we think it will be found to their interest to establish mills for the express purpose, for the quantity of light rails required for America, Canada, India, Egypt, and other countries will doubtless be very great, and unless manufacturers at home are prepared to meet the demand, the business will be diverted into other channels. The Americans, for example, who now make half their own heavy rails, will start mills for the manufacture of light rails, and a great deal of the manufacture will be carried out on the Continent, unless manufacturers at home are prepared to fall in with the new requirements caused by the success of light railways, and offer to consumers the same facilities for procuring light rails from England that they now provide for the purchasers of heavy ones.

DEFINITION OF ENGINEER.

To the Editor of Engineering.

Sir,—Under the heading "Definition of Engineer," I observe a letter in your paper of the 29th of September last, to which I hope you will allow me to offer a word or two in the way of reply.

I would have done so earlier, but as I am a sea-going engineer (or rather, what "A Junior Assistant" would designate me, a "marine engine driver"), and being out on a foreign voyage on the date of your publication, I had no opportunity of perusing your paper until this, my return voyage. I agree with much "A Junior Assistant" advances about gas-fitters, smiths, boiler-makers, and the majority of locomotive and stationary engine drivers having no right to be called engineers; I object, however, to sea-going engineers being termed "marine engine drivers;" nay, more, I assert that if any class of men possess the right to be called mechanical engineers sea-going engineers possess that right.

The Board of Trade has thought our position and qualifications worthy of legislation, and the necessary theoretical and practical knowledge required of a candidate before obtaining a certificate of competency fully entitles the possessor to the name of engineer.

The ingenuity to devise remedies, and the promptitude and energy necessary to execute the repair at sea of disabled engines, always under difficult and often dangerous conditions, with inadequate resources, call for the exercise of mechanical abilities of no mean order.

I will not trouble you further, but hope I have proved the right of my class to the name of engineer. And, in conclusion, I would, in all humility, implore "A Junior Assistant" to permit us to retain it.

I am, Sir, yours respectfully,

A Chief Engineer, Cunard Service.

Gibraltar, November 4, 1871.

BURNING COAL GAS.

To the Editor of Engineering.

Sir,—I have read your article on "Burning Coal Gas" in Engineering for October 6th, with great interest. About six years ago, I made some experiments similar to those referred to in your article, but as the principles to which these experiments pointed, seemed to be taken advantage of in the construction of some gas burners then in the market, I presumed that the principles themselves were well known to gas engineers, so thought it unnecessary to call attention to the subject.

Having noticed what I am sure is familiar to many, that when two gas flames are burned so as to impinge against each other, and form one flame, there is a marked increase in the light compared to what the two flames give when burning separately, I made experiments to test the increased amount of light from this method of burning gas. On referring to my notes of these experiments, I find that—using fish-tail burners—when two No. 0 burners were used, the light was nearly three times greater when burned together then when burned separately; with No. 2 burners, it was twice greater, while with No. 4 burners it was scarcely one-third greater. The next point to be ascertained was, the amount of gas consumed by the different burners used. I was much astonished to find that whilst the No. 2 burner gave four times the light of the No. 0 burner, it only used 1.37 times the gas. And the No. 4 burner gave 7.7 times the light and only burned 1.6 times the gas. From these experiments it was clear that the small sizes of burners are the most uneconomical form of burner that can be used, and that when a number of burners are required for a room, the larger sizes of burners ought to be used, as they give the same amount of light with much less gas, and further, that the increased light got from the double burners was almost entirely due to the defects of the single burners used.

Wishing to ascertain if the economy of the different burners was due to the different pressures at which the gas issued from the jets, I removed the burners from their sockets and allowed the gas to rush freely from the pipes, when it was found that the number of revolutions per minute made by the meter was increased but little from what it was when using No. 4 burners, which showed that the gas issued from the No. 4 burners under very small pressure, and, therefore, with small velocity, which at once gave the reason for the different economy of the different burners. The gas from the small sized burners issuing with considerable velocity, dragging the air along and mixing it up with itself, tending to produce a flame approaching that of the Bunsen burner type. That this is the true cause of the small illuminating power of the small sizes of burners may be proved by fixing two burners with their open ends together, say a No. 0 to a No. 3 or a No. 1 to a No. 4. When this compound burner is placed with large size end in socket and gas burned at small size end, the usual pale uneconomical flame is produced, but when reversed so that the gas passes first through the small burner and then burned at large size end, the flame is increased in size and greatly increased in illuminating power, though in both cases burning the same amount of gas.

The greatest economy in gas burning would appear to be attained when the supply of gas is just quick enough to keep up a temperature sufficiently high to enable the carbon of the gas to combine perfectly with the oxygen of the air. If the supply is too slow to keep this temperature, part of the carbon passes away as smoke. If the supply is too quick, too much air gets mixed up with the gas, reducing its illuminating power. It will be very difficult to make a burner that will pass gas at only the best speed when working under the different pressures, produced by the different pressures used by the different works, the nearness or distance of the works, size of pipes, and also from the different qualities of gas supplied. But a burner might be made with a regulator to be set to suit the average pressure at the place where it was to be used. Or perhaps the simplest plan would be to have one self-acting pressure regulator for each house, placed on the main pipe at the first convenient place after leaving the meter.

Yours truly,

John Aitken.

Darroch, Falkirk, November 4, 1871.

"A STEAM ENGINE TRIAL."

To the Editor of Engineering.

Sir,—I have perused with pleasure your very full and exhaustive account of the performance of the engine at Hele Works, in Engineering of November 3. One part of it, however, surprises me. It is stated, that "throughout the day, every endeavour was made to keep the work to be done as constant as possible, by charging the rag engines in succession." In conjunction with this, you state that the speed of the engine was kept very regular, varying from 47.9 revolutions per minute to 42.0 revolutions, the mean for ten hours being 46.51 revolutions.

Now, according to my experience, which is considerable, with Corliss engines, and at paper mills, the variations of speed above noted are excessive. It is to be presumed that they are correctly recorded, or else a doubt rests on the accuracy of the whole statement. I would characterise this work not as "very regular" but as *very irregular*. Some explanation will be esteemed by yours, &c.,

Investigator.

["Investigator" having had experience in the working of engines at paper mills, must be well aware of the difficulty which exists in maintaining a steady load on such engines when employed to drive rag engines. In the case of the experiment at Hele, this difficulty was experienced to some extent during the first two or three hours of the trial, and it was during these hours that the maximum variation of speed occurred, the speed during all the later portion of the time scarcely varying one revolution per minute. Even during the early part of the trial, however, the speed was not "irregular" in the ordinary sense of that term. The engine was simply driven at different speeds, and there were no frequent and sudden changes of speed such as are ordinarily known as irregularities. The total number of revolutions made being registered by a counter and the series of indicator diagrams being taken at frequent intervals, the alterations of speed to which our correspondent refers in no way affect the accuracy of the results deduced.—Ed. E.]

GLASGOW UNIVERSITY.

To the Editor of Engineering.

Sir,—In your impression of Friday last, under the heading "Glasgow University," you gave notes of the introductory lecture delivered by Professor Gustav Bischof, in Anderson's University. Now any one not knowing to the contrary, would suppose that the Glasgow University and Anderson's University were one and the same Institution. Not so, however, Anderson's University being quite distinct from Glasgow University, and forming no part of it.

Anderson's University is a self-assumed title. It possesses no charter, and, consequently, has not the power to grant degrees. It is, however, a very important science and medical school, and has for its professors able and learned men, of which not the least eminent is Professor Gustav Bischof, late of Bonn.

I am, Sir, yours respectfully,

J. McK.

Glasgow, November 13, 1871.

IRON ELECTROTYPE.

The art of electrotyping, which owes its discovery almost to accident in the year 1839, has since that time grown into a very extensive branch of manufacture. The discovery of this most useful art was made almost simultaneously in England and in Russia. In England Mr. Thomas Spencer and in Russia Professor Jacobi have to be individually credited with the invention, which has since been developed and brought to the degree of perfection in which we now find it in daily practice. So far the reproductions of engraved plates, medallions, and objects of art have only been effected in the softer metals, such as gold, silver, and copper, although attempts were long since made to reproduce them in iron. Few persons probably were aware, however, that this important object had been accomplished, until, like ourselves, they saw a case containing some beautiful specimens of iron electrotype in one of the corridors of the late International Exhibition, at South Kensington. The specimens were placed there about three months before the close of the Exhibition, and were exhibited by Messrs. Bryan Donkin and Co., of Bermondsey, as agents for the inventor. These specimens consisted of bank-note and various other plates, medals, medallions, and a page of printing type electrotyped in iron. This new process has been perfected by M. Eugène Klein, who is at the head of the chemical department in the Imperial State paper manufactory in St. Petersburg. Many difficulties have arisen and have been successfully surmounted in developing this process to its present practical issue. Attempts were made to effect the object so far back as the year 1846, but which were unsuccessful, and it was about 20 years before the problem was definitely solved. The importance and reality of the progress, however, are now unquestionable, and an extended knowledge of the process must inevitably lead to its general adoption. At the present time we believe its application is confined to the Russian Imperial State paper works, where it has been in active operation for the past three years, the iron plates replacing those of copper for bank-note printing and for other similar purposes. The application of the invention, however, extends to all the other branches of the art of electrotyping as demonstrated by the specimens to which we have already referred.

From a paper upon the present subject, read by Professor Jacobi before the Academy of Sciences in Russia, in 1868, it appears that in the previous year M. Fenquières sent to the Paris Exhibition some specimens of iron electrotype which presented a fair appearance as regarded surface, but still were inferior to those produced by M. Klein in the year following. M. Fenquières does not appear to have published the process by which he obtained his results, and he, moreover, only spoke of it with the greatest reserve. Professor Jacobi, however, states on the authority of Professor Varrentrapp, of Brunswick, that the process and the bath employed differ essentially from those of M. Klein, whose results may be considered as being perfectly independent.

Referring to the process of electrotyping in iron, Professor Jacobi observes that the good quality of the iron deposit depends principally upon the greater solubility of the anode. The augmentation of its surface not having produced the desired effect, M. Klein conceived the idea of combining the anode of iron with another of copper. The professor varied this combination by replacing the copper with horn charcoal, which gave more powerful results. The effects of this combination were thus rendered complete, the metal negative combined with the iron in the same bath formed a duplicate layer, which worked as a cathode opposite the iron, and as an anode by its combination with the copper wire, or the positive pole of the pile which furnished the principal current. The surface of this electrode consequently disengaged hydrogen and oxygen simultaneously, which combined in the proportions which form water. The surplus hydrogen freely disengaged itself, or produced a polarisation of the electrotype. If, observes the professor, the oxygen is most abundant, and if the electrotype consisted of an inoxidable substance, such as horn charcoal, it would also have disengaged gas, and have given a feeble polarisation. If, however, the electrotype is oxidable like copper, it will be oxidised and dissolved. By immersing a galvanometer in the circuit, Professor Jacobi has observed the deviation of the needle diminish by degrees, whilst the current was very feeble, and it became perfectly still after the force of the current had been increased to a certain degree. At length, passing that degree, the professor noted that the deviation again became inconstant. By means of the galvanometer, it therefore becomes easy to so regulate the current as to disengage neither the oxygen nor the hydrogen from the cathode.

So far Professor Jacobi. Turning now to a letter from M. Klein which was placed before the Russian Academy of Sciences in 1868, we have recorded the methods employed by him in the production of iron electrotype. M. Klein saw M. Fenquières' specimens at the Paris Exhibition, and, encouraged by Professor Jacobi, he, on his return to St. Petersburg in October, 1867, renewed his attempts to electrotype in iron. The scientific interest which attached to the new development, and the eminently useful applications of which he saw it was susceptible, especially in the departments of engraving and printing, stimulated M. Klein, and in the early part of 1868 he had accomplished his object. The medals produced in the early part of M. Klein's researches showed on their reverse porosities and deep hollows which penetrated nearly through the thickness of the deposit. These cavities were also observable in great numbers in the productions of M. Feuquières. In M. Klein's later specimens these singular cavities—which probably proceeded from bubbles of gas—entirely disappeared, and their reverses are in no way inferior to those of copper specimens produced under the best conditions. The starting point of M. Klein was the steeling of engraved copper-plates, which process was effected in a bath composed of the chlorates of ammonia and iron, to which he added a small proportion of glycerine. Those, however, who have paid attention to this steeling process have had occasion to remark that in giving the deposit of iron a greater thickness, the surface cracked, and the deposit detached itself from the cathode in excessively brittle flakes. It became necessary, therefore, to employ baths of two different classes composed of sulphate of iron and sulphate or chlorate of ammonia. Finally, M. Klein devised three baths after the formulæ $FeO, SO_3+NH_4O, SO_3+6HO$.

The first bath consists of a concentrated solution of crystals of double salt $FeO, SO_3+NH_4O, SO_3+6HO$ above mentioned. The second bath was composed by mixing the concentrated solution of each of these two salts in the proportions of their equivalents. At length M. Klein obtained the third bath by taking a solution of sulphate of iron, precipitating the iron by carbonate of ammonia, and dissolving the precipitate by sulphuric acid, getting rid of all excess of acid. In preparing the baths of the second class, M. Klein, as we have stated, mixed the solutions of chlorate of ammonia and sulphate of iron in the proportions of their equivalents. Another method employed is to dissolve in a solution of sulphate of iron as much chlorate of ammonia as it will readily absorb at a temperature of about 66° Fahr. All these baths were concentrated as highly as they could be. As an anode, M. Klein employed iron plates giving a surface about eight times that of the copper cathode. In using a Daniell battery for the decomposition the deposit was formed in 24 hours upon the whole of the cathode. The deposit, however, was full of flaws, and was easily detached and broken up into fragments. As it often happens that the solution of sulphate of copper improves by use, M. Klein hoped that the iron solutions would act in a similar manner. He therefore continued the experiments for several days without, however, obtaining any better results. Under the advice of Professor Jacobi, instead of a pair of Daniell cells for each of the five stages of decomposition, he then employed four pairs of feebler Meidinger cells, uniting them in series with the five stages of decomposition. This arrangement was found to give a smaller development of hydrogen at the cathodes, and better final results. The deposits, however, were not yet perfect, some exhibiting porosity and others being furrowed.

Conceiving from previous experience that this was due to acidification of the bath, M. Klein tested it, and found a very decided acid reaction. He attributed this acidification to the circumstance that the quantity of iron deposited on the cathode was greater than that dissolved by the anode. It was, therefore, necessary to give the anode a greater degree of solubility, and as that could only be effected by increasing its area, M. Klein conceived the idea of placing in the bath a plate of copper, and uniting it with the iron. The result of this combination was very remarkable; not only were the baths of the first class rendered neutral after several hours, but the deposits became much more uniform. Their colour was a dull grey; they adhered perfectly to the cathode without warping or cracking in any part. During the first 24 hours the surfaces remained perfectly even, but afterwards they began to exhibit minute cavities similar to the appearances often produced upon galvanic deposits of copper. These cavities, however, rarely penetrated to the depth of the deposit. Their production is attributed to the superabundant disengagement of gas on the surface of the cathode. It probably happens that these bubbles attach themselves strongly enough to hinder the formation of the deposit. If the energy of the current becomes too great, these annoying phenomena are produced more frequently. By reducing this energy in the process, and having only an imperceptible disengagement of gas, by diminishing the concentration of the bath, or augmenting the resistance of the solid portions of the circuit, the formation of these cavities entirely disappeared, and the beautiful results to which we have already referred have been obtained. A microscopical examination of the reverses of the deposits produced by M. Klein's final process fails to discover any porosity or irregularity in the specimens.

On leaving the bath the iron is as hard as tempered steel, and very brittle. Reheated to a dull red heat it loses much of its sharpness and hardness. Heated to a cherry red, it becomes malleable, and may be engraved as easily as soft steel. If the deposits are produced in good condition, and annealed uniformly and with the necessary precautions, they are neither subject to warp nor bend. There is no contraction, but on the contrary, a slight degree of expansion, almost imperceptible, however. Owing to the necessity of having bank-note and similar plates identical in every respect, it is of the first importance that they should not be distorted, nor have their dimensions altered in the process of annealing. It appears that the galvanic deposit of iron has not only permanent magnetism, but that, like soft iron, it receives the magnetism of position.

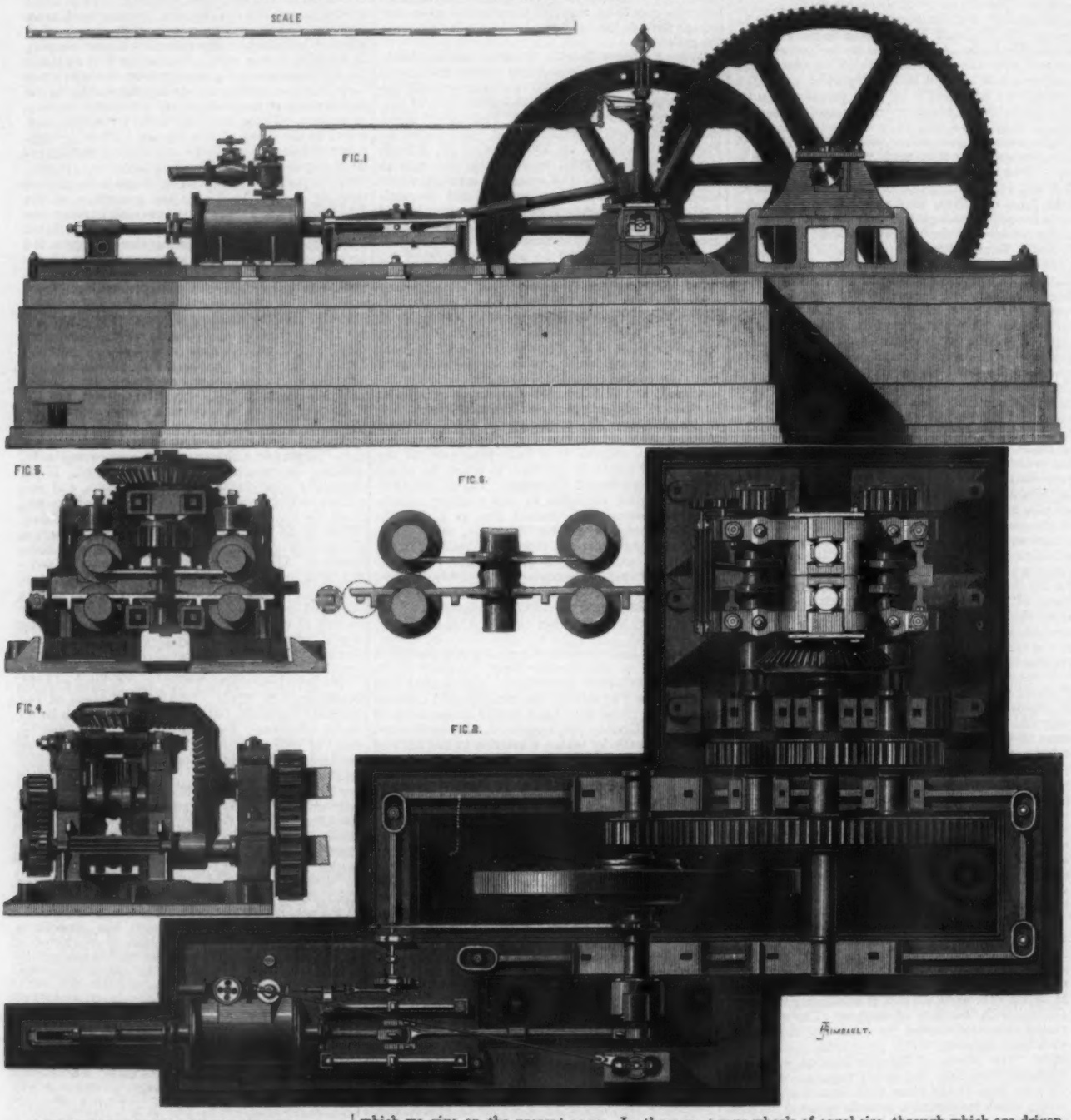
We have now received both the failures and the successes of M. Klein. Of the importance of the practical application of the process there can be no doubt whatever. By replacing plates of copper by those of iron greater facilities will be afforded for producing publications, works of art, and especially bank-notes and cheques. Iron electrotype plates are found to be almost indestructible. They not only can be printed from an almost unlimited number of times; but they are better calculated than those of copper to withstand those inevitable accidents constantly occurring in printing establishments. Printers are sometimes obliged to set aside as useless their best plates, which are often damaged by a grain of sand, or by a chance knot in the paper. These accidents not only involve the expense of renewing the plates, but sometimes occasion interruptions and delays in works of a very pressing nature. These are some amongst the many which may be expected to accrue from the introduction of iron electrotype.

The Darien Canal Question.—The greatest engineering difficulties in the Darien canal scheme, proposed by Commander Selfridge of the United States navy, occur near the Pacific slope. A tunnel 170 ft. in height and 70 ft. wide will have to be run through the hills for 5 miles, and for 3 miles the proposed canal will have to be in a cutting of some 125 ft. in depth. The total excavations estimated to be required by Commander Selfridge are 31,234,105 cubic yards of rock, 7,424,240 cubic yards of tunnelling, and 10,461,627 cubic yards of earth. The estimated cost of carrying out the work is 124,824,290 dol.

American Steam Shipping.—The American Pacific Mail Steamship Company has closed contracts with the Harland and Hollingsworth Company of Willington, Delaware, and Messrs. Roach and Steers, of New York, for the construction of three iron screw steamers with compound engines of 400 horse power nominal, and having capacity for 2000 tons of cargo, besides their coal and stores. These steamers are intended to run between Aspinwall and New York, or between San Francisco and Panama, as may be required. The company is also about to contract for two iron steamers for its China line, with compound engines of 600 horse power nominal, and carrying capacities of 4000 tons each.

WHILE'S BLOOMING MILL AT THE BRITANNIA IRON WORKS, MIDDLESBROUGH.

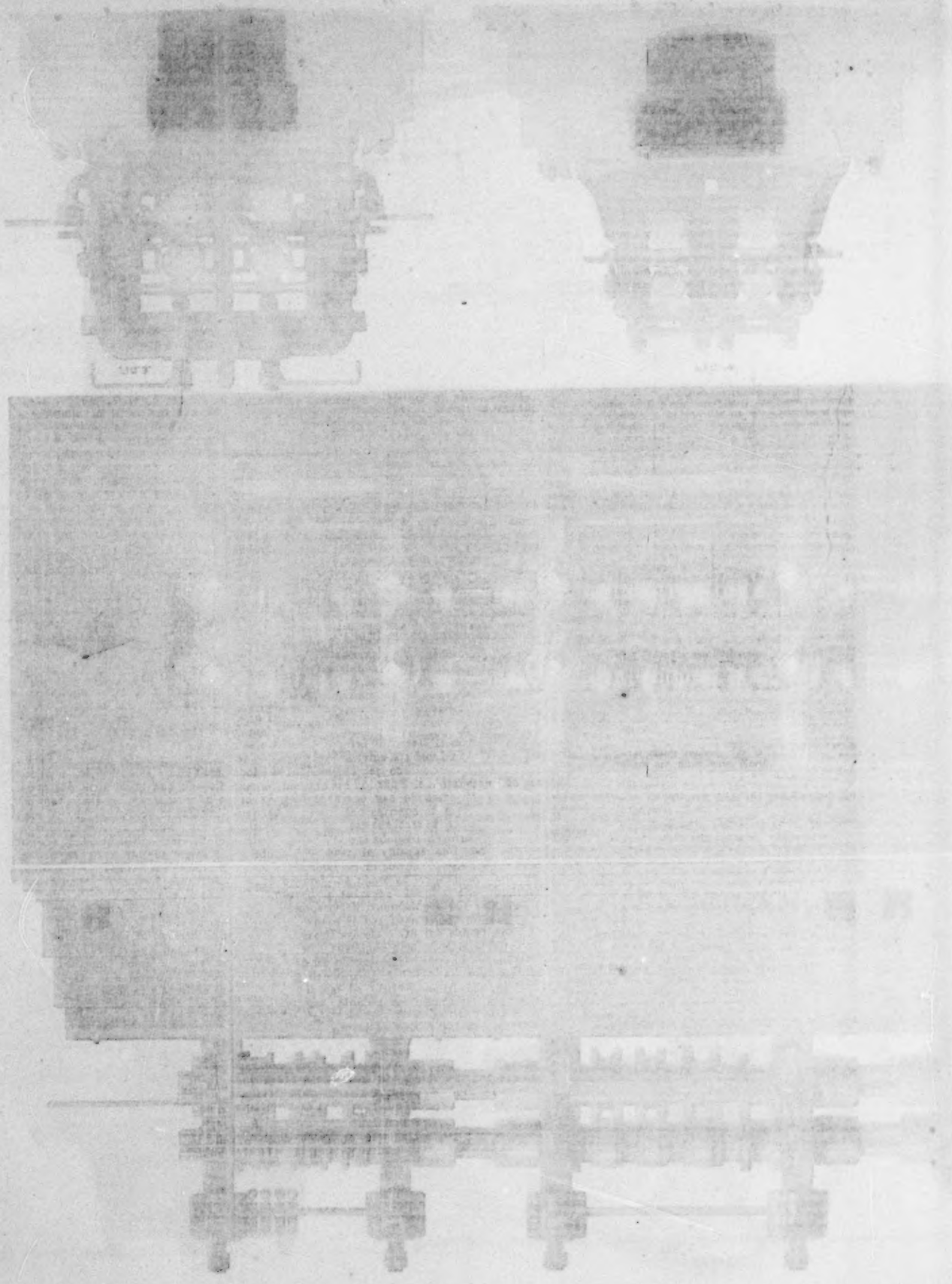
CONSTRUCTED BY MESSRS. CLARIDGE, NORTH, AND CO., ENGINEERS, BILSTON.



THE BRITANNIA IRON WORKS.

(*Continued from page 322.*)

The blooming mill, situated at the point marked M, in the general plan of the works on page 298 of our last number but one, is on Mr. Charles While's patented system, and has been constructed by Messrs. Claridge, North, and Company of Bilston. In this form of mill, which has been used with considerable success in the South Wales district and elsewhere, and of which we have spoken on former occasions in this journal, the blooms pass successively between three pairs of rolls arranged one behind the other, the first and third being in a horizontal and the second pair in a vertical position. The whole arrangement is shown clearly by the engravings of the mill at the Britannia Works, which we give on the present page. In these engravings, Fig. 1 is a side elevation of the mill and engine, Fig. 2 a corresponding plan, Figs. 3 and 4 respectively a transverse section and front elevation of the mill, while Fig. 5 is an enlarged diagram view showing the three sets of rolls in their relative positions and removed from their housings. The mill is driven by a horizontal engine with 24 in. cylinder and 3 ft. stroke, this engine, which was also constructed by Messrs. Claridge, North, and Company, being run at 60 revolutions per minute. The fly-wheel shaft of the engine carries a pinion which gears into a spur wheel on a second motion shaft, the ratio of the gearing being about six to one. This second motion shaft also carries a mitre wheel driving the vertical rolls, as shown in Figs. 1 and 4, and a spur wheel which gears into two other spur wheels of equal size, through which are driven the bottom rolls of the two horizontal pairs. The two rolls of each pair, both vertical and horizontal, are geared together in the usual way, and it will be seen that the arrangement is such, that all the sets of rolls revolve in the same direction. The diameter of the rolls is 13 in., and their speed about ten revolutions per minute. The first pair of horizontal rolls and the vertical rolls are roughed, while in front of the first pair of horizontal rolls is a fluted feed roll driven by gearing as shown. Guide plates, also, arranged as shown in Figs. 3 and 5, are provided between the sets of rolls. The blooms are brought on a bogey by one man to the leading part of the mill, and after passing continuously between the three pairs of rolls in a few seconds, are caught on the other side on a bogey drawn by



BROWN'S RAIL-MILL AT THE BRIT

CONSTRUCTED BY MESSRS. CLARID

(*For Des*

FIG. 1.

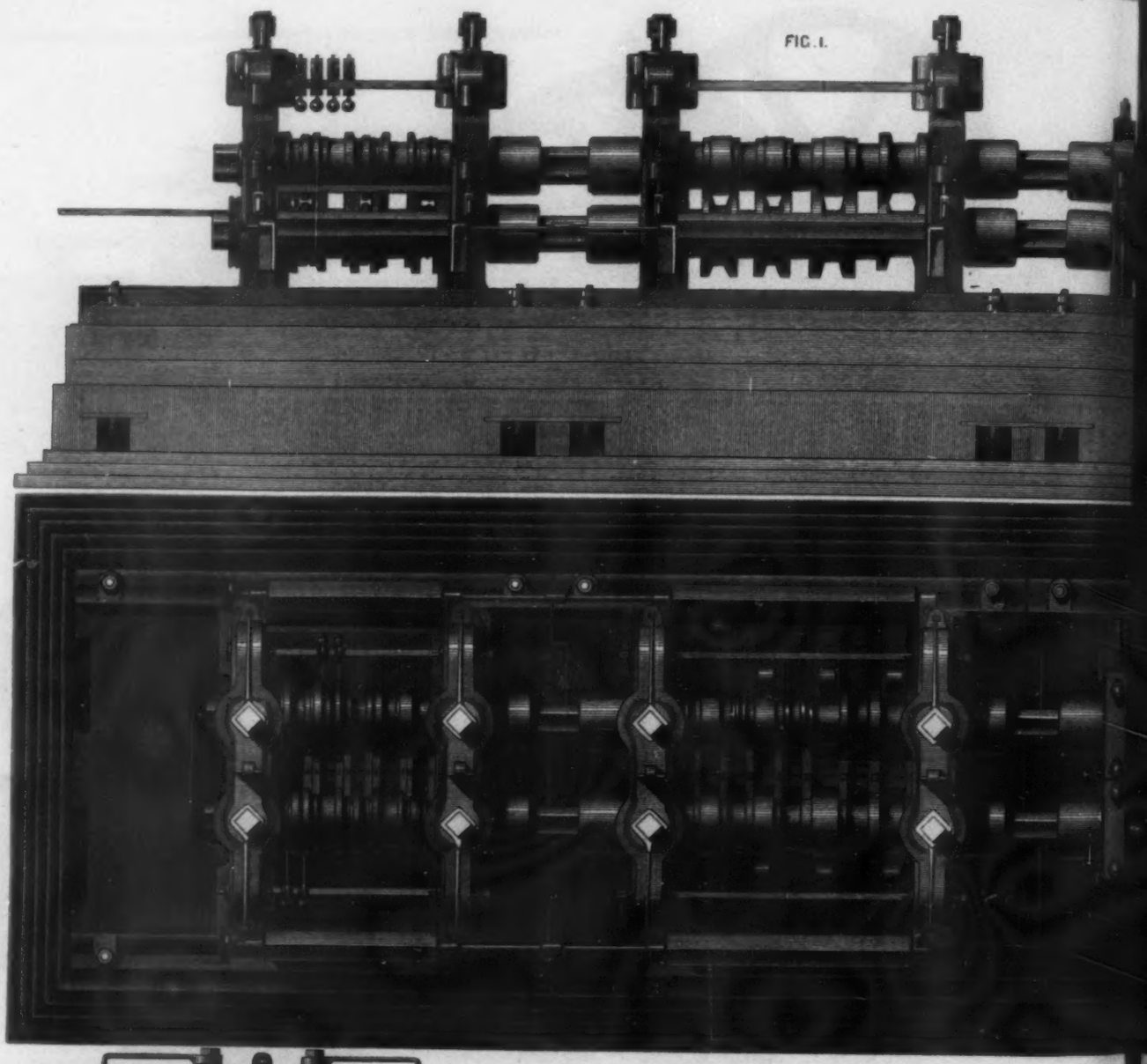


FIG. 3.

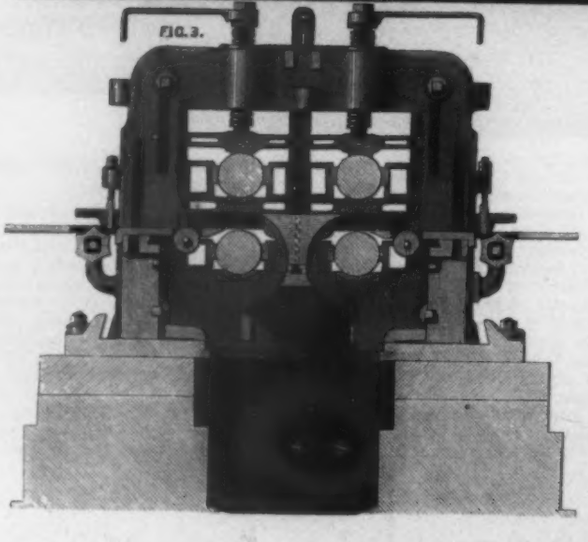
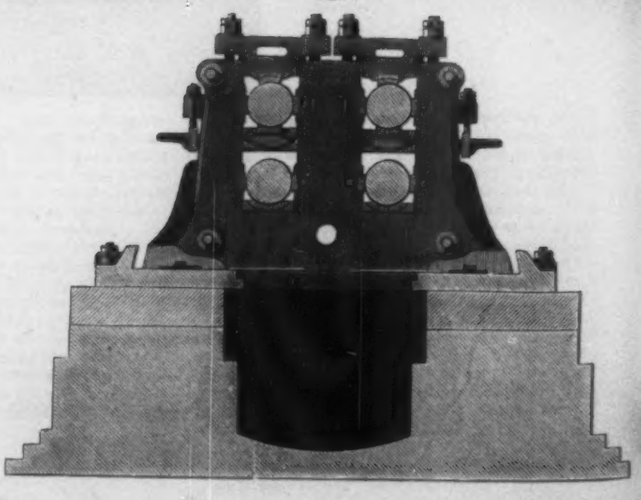


FIG. 4



IA IRON WORKS, MIDDLESBROUGH.

TH AND CO., ENGINEERS, BILSTON.

Page 332.)

SCALE

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FIG. 7.

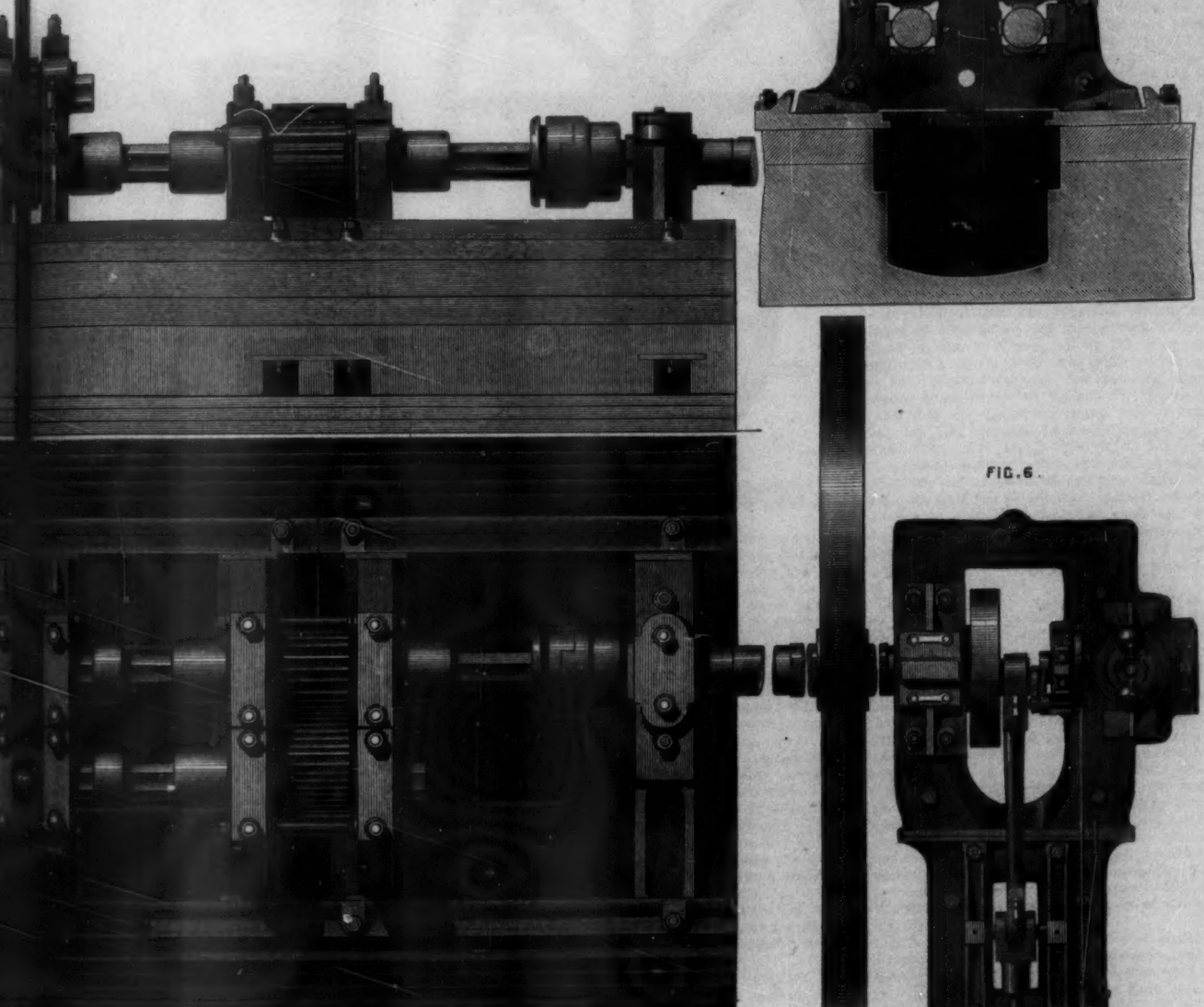


FIG. 6.

FIG. 8.

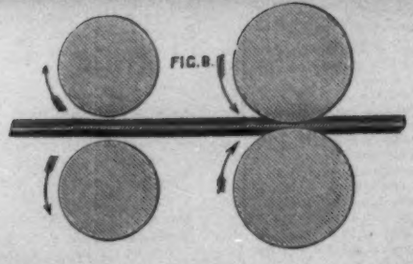
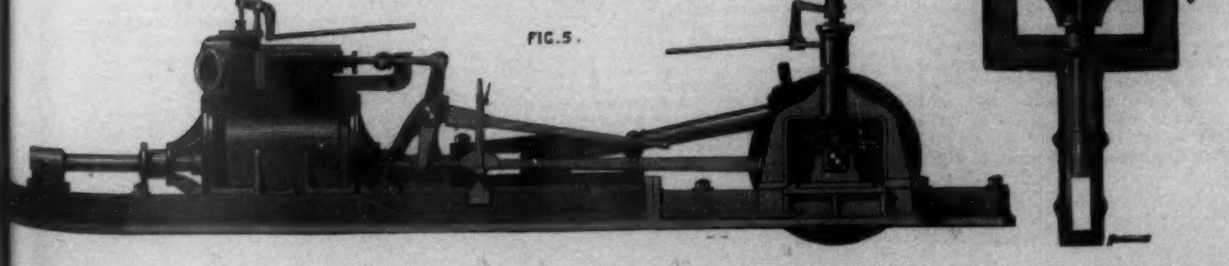
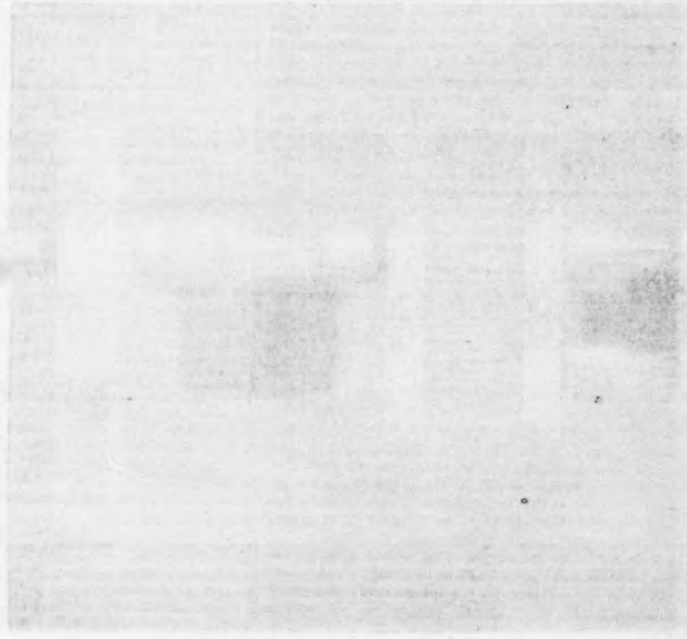


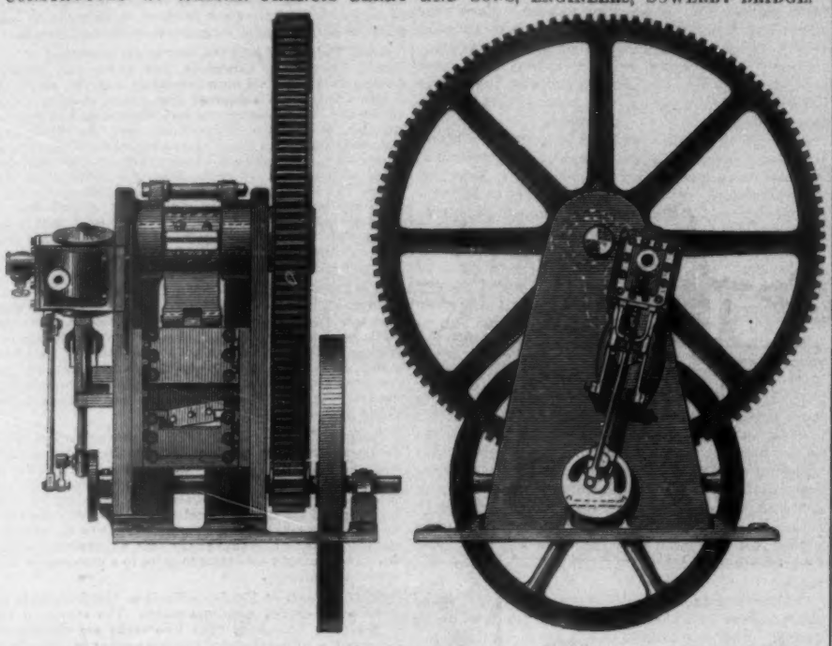
FIG. 5.





SCRAP SHEARS AT THE BRITANNIA IRON WORKS.

CONSTRUCTED BY MESSRS. FRANCIS BERRY AND SONS, ENGINEERS, SOWERBY BRIDGE.



one man and conveyed to the re-heating furnace where they are subjected to a wash heat, and are then ready for being rolled off into finished rails by the rail mill.

This latter mill, which forms the subject of our two-page engraving this week, has also been constructed by Messrs. Claridge, North, and Company, and it is on the patent system of Mr. William Brown, of Smethwick. The peculiarity of Mr. Brown's mill consists in the employment of two sets of rolls placed one in front of the other, these sets being driven in opposite directions. Each set of rolls has turned in it the ordinary working grooves, alternated with enlarged grooves through which the iron can pass without being acted upon, the arrangement being such that the enlarged grooves of one set of rolls are directly opposite the working grooves of the other set. The two sets of rolls running, as we have said, in opposite directions, it follows that the iron introduced through one of the enlarged grooves of the first set will be acted upon by the corresponding working grooves of the second set, and can then be passed back through the adjoining enlarged grooves of the second set to be operated upon by the corresponding working grooves of the first set, and so on. The bloom or rail can thus be passed continuously backwards and forwards through the mill without there being any necessity for reversing the rolls, and hence much time is saved. Before being adopted at the Britannia Works, Mr. Brown's mill had only been used for producing small sections, and its exclusive employment for rail rolling was, therefore, a somewhat bold experiment; but it was an experiment of good promise, and it is gratifying to know that it has turned out well.

In our two-page engraving Fig. 1 is a front elevation and Fig. 2 a plan of the mill; while Fig. 3, is a side view of one of the roll housings showing the chucks and brasses; Fig. 4, is a side view of the double pinion housing; Figs. 5 and 6 are respectively a side elevation and plan of the engine by which the mill is driven; Fig. 7, is a side view of the single pinion housing; and Fig. 8 is a diagram view showing the two sets of rolls in their relative positions and a rail passing through them. The fly-wheel shaft of the engine is coupled direct to the lower rolls of one set, while the lower rolls of the other set are driven in the reverse direction by the single pinions of which the housings are shown in Fig. 7. The double pinions of which the housings are shown in Fig. 4 are for the purpose of communicating the motion from the lower to the upper rolls. The mill has a double set of roughing and a double set of finishing rolls, the former being 7 ft. and the latter 5 ft. long, and it is altogether an excellent piece of work reflecting great credit on its designers and makers.

The engine by which the mill is driven, was constructed by Messrs. Martin Samuelson and Company, of Hull, and, as will be seen from the views of it given in our two-page engraving, it is of a similar type to those made by the same firm for driving the forge trains at the works we are describing. The engine for the rail mill is, however, smaller than those for the forge trains, the stroke being but 3 ft., while the diameter of the cylinder is the same, namely, 36 in. As we described this type of engine when speaking of the forge trains, it is unnecessary that we should say more concerning it here.

We have already mentioned the large shears for cutting up scrap, placed in the position marked K, in the general plan of the works, and we now give on the present page an engraving of these shears. They have been constructed by Messrs. Francis Berry and Sons, of Sowerby Bridge, and are of a very simple but powerful type. They are driven, as will be seen, by an engine attached directly to them, the crank-shaft of this engine carrying a pinion which gears into a large spur wheel on the eccentric shaft, which gives motion to the shearing blade. The framing is very massive, and the shears are well adapted for heavy work.

We shall next week complete our account of the Britannia Works by describing the appliances used for finishing the rails after leaving the rail mill.

(To be continued.)

ENGINEERING SOCIETY, KING'S COLLEGE.—At a general meeting of this Society held on Friday, 17th November (Mr. Hunter, president, in the chair), a paper was read by Mr. J. N. Douglass "On the Wolf Rock Lighthouse." Mr. Douglass commenced by describing the features of the rock which is situated nine miles S.W. of the Land's End, and springs almost direct from water of 34 fathoms to the level of high water to the S.W. A shoal of 4½ fathoms at low water, extends for a distance of half a mile, beyond which again the water deepens to 14 fathoms at the distance of about a mile. He next described the material (Cornish granite) and the method of dovetailing, giving some account of the difficulties under which the men laboured from the roughness of the sea and the short duration of time that they were enabled to be on the rock at a stretch. He then mentioned the use of a steam crane as soon as a dry foundation had been prepared for it, going on to describe the interior arrangements of the house and lantern, concluding by enumerating the number of men employed in the yard and on the rock (sixty), and the total number of hours spent on the rock from its commencement in March, 1862, to its completion in July, 1869, giving an equivalent to 101 working days of 10 hours. At the close of the paper, a discussion ensued with reference to the distance at which the light is visible, the machinery for rotating it, and that for striking the fog bell.

LITERATURE.

A Digest of Facts relating to the Treatment and Utilisation of Sewage. By W. H. CORFIELD. London and New York: Macmillan and Co. 1871.

SECOND NOTICE.

VERY numerous are the schemes suggested, and put in practice with more or less success, which Mr. Corfield chronicles in his book. About 1862, the so-called Eureka system was tried in Manchester. It consisted in the application of pails containing some disinfecting fluids, below the privy seats, the said pails being left till they were full, and then removed, covered with a tight lid, and conveyed to the factory, an empty pail being substituted for that removed. Arrived at the works, the contents of the vessels were mixed with ashes, treated with disinfecting fluids, and converted into a poor manure, which would not pay for removal to any distance. After a few years' trial, the scheme was abandoned, but whether owing to its unprofitable nature, or to the abominable nuisance it created, and the danger of infection it possessed, or whether the result was due to all these causes we do not know.

Next came the Goux system, experimented upon amongst other places at Salford. This also is a modification of the pail method, and according to it the vessels placed under the privy seats are lined with refuse animal and vegetable fibrous matters to act as absorbents, and mixed with a little sulphate of iron or of lime. With this compound the sides and bottoms of the tubs are lined, and applied in the ordinary manner. In reporting upon this system when in use at Salford, Dr. Buchanan reports that the absorbent lining was of but little use, but Mr. Corfield expresses himself in somewhat favourable terms upon it, it being always understood that the system receives fair play. But when the best is made of any plan which involves the accumulation of dejected matters beneath the privy seat, and their frequent removals, a large amount of inconvenience and no little danger must result, and the most that can be said is that such systems are better than the previous abominations of primitive middens.

In referring to the modes of utilisation in vogue so far as regards those systems already referred to, Mr. Corfield points out that, according to reliable data, the average amount of ammonia "voided annually by an individual of a mixed population of both sexes and all ages is, in urine, 11.32 lb., in fœces 1.64 lb., total 12.96 lb., and that the estimated money value of the total constituents is, in urine, 7s. 3d., in fœces 1s. 2¾d., total 8s. 5¼d." This estimate is considered too high by some experienced manipulators of the material, who assess the practical sewerage value per head per annum at 6s. 8d. It is well to bear these figures in mind, in considering the question of sewage utilisation, and especially it should be noticed that the amount and value of ammonia contained in the urine would undoubtedly make it absolutely necessary that any process to be successful should preserve this element. We shall come to consider this part of the question further on.

It is obvious that the difficulties of dealing with sewage matters increase in an alarming ratio to the density of the population; the refuse of a village can be dealt with, although we have seen many villages where it was left to breed fever, and where it did so most successfully, but in towns the obstacles are much more serious.

In country places where manure is required, the contents of the middens, ashpits, &c., are sold readily at a cheap rate to farmers, who cart it away, and in some places, where a unison of feeling exists, every man does not heap up his own muck-heap, but the whole refuse of the community is accumulated, sold when convenience offers, and the proceeds divided among the joint producers. In towns it is needless to say this primitive plan is inadmissible: in Manchester, for instance, the value of the dejections and ashes do not pay for collection and removal. We have so often referred to the process in vogue in France, that it is needless to give space to a notice of it here; we may say, however, Mr. Corfield gives some interesting statistics with reference to it, and pass on to the results obtained from the sale of the contents of the pails collected by house-to-house visitation. The evidence upon this point shows that the system can be made to pay—a matter quite apart from practical and sanitary considerations—for the

sewage is collected almost free from mixture with foreign bodies. At Gröningen, the yearly profit amounts to 1600*l.*, at Antwerp to 2700*l.*, at Ostend to 700*l.* At Strasbourg the income just balances the expenditure, and at the Carlsruhe barracks, where 2800 men are quartered, about 250*l.* a year are realised. In many places the expenses are in excess of the receipts; this is of course owing to many causes, the chief being the market value of the manure, and the mean distance it has to be conveyed. Thus at Stockholm there is a deficit of 2000*l.* a year, at Nottingham the same, and in Glasgow there is a loss of 9000*l.* annually.

In summing up his conclusions upon the systems already considered, Mr. Corfield says: "We have now dealt with the treatment of liquid manure, as such in the various forms of cesspools, pails, tubs, and so forth, without the addition of any notable quantity of extraneous matters, whether with a view to the dryness or the disinfection of the contents, and also, on the other hand, with its treatment by the admixture of a sufficient quantity of ashes and other refuse (as in the various forms of midden pits and closets), to render the whole a more or less solid dry mass. We have seen that the former of these systems is as a general rule connected with a considerable amount of nuisance either in the collection or the removal of the excremental matters, or in both of these particulars, and although one modification of this system has practically succeeded in an economic point of view in certain countries, and even in a few of our own towns, it can never be looked upon as a solution of the question of removal of excrement, which can be adopted generally by the community as a final one, or even as a suitable one.

"With regard to the second of these systems we have seen that it is almost invariably connected with great nuisance, both in the storing and in the removal of the contents of the pits or closets, and that it possesses the additional disadvantage of the necessity of disturbing these contents in order to remove them. . . . In neither of these systems is there any provision made for the removal of the liquid house refuse from slops, washing, cooking, and so forth, so that all these, and generally the chamber-slops as well, have to be thrown down the sink, and pass away into the sewers, thus necessitating the purification of the sewers in some way, and leaving the great question unsettled. Indeed, the amount of purification which would accrue to the sewage from such a proportion of excremental matters, and nothing else being kept out of it, is not nearly so great as is generally supposed, the other refuse matters that the sewers necessarily carry away from all towns being so great in amount that it is certain that, even if all the excremental matters could be kept away from the sewage, it would now be sufficiently pure to be allowed to empty itself into a river, and the necessity of pumping it would arise as much as ever."

Advancing from the incomplete and partial systems which, sometimes under favourable circumstances, with success, but more often with failure, have been experimented upon and used largely, we arrive at the two main systems, which at present, in one form or other, appear best able to deal with the great difficulty of the disposal of the sewage. These are the dry closet system, which excludes excremental matters entirely from the sewers, and by deodorizing them, render them facile of removal, and the water-closet system, in which the sewers are made the common receptacles of all discharges, and water is made the medium of conveying them, to a suitable point of outlet.

Passing over some less important arrangements of the first-named system, we come to the one which has achieved a considerable publicity, viz., Moule's patent earth-closet, in which *dry* earth is employed as the deodorizing or concealing medium. From 1½ lb. to 2½ lb. of such earth in India, are necessary for combining with each dejection, and it is a singular fact, that after a time, no excremental matter whatever can be detected in the mixture, and all extraneous material, such as paper, disappears also. It is possible to employ the same earth repeatedly if desired, so long as the one essential—dryness—is observed. It is easy to understand that a mechanical contrivance of the simplest nature fulfils all the requisites in supplying the earth as required, and the result obtained when it has been applied, even on a comparatively moderate scale, leaves no doubt as to its efficiency. Besides the really extensive use to which this system is placed in private houses, many schools and several public institutions are furnished with it and with good results. Where fever resided before its employment, it has left, and at the Dorset County Jail, which is supplied with the closets, not only is the result all that can be desired, but the sale of the earth realises 10*s.* per head per annum. Each year since 1868, Moule's earth closets have been adopted at the Wimbledon volunteer camp, with doubtful success; it is pretty evident, indeed, that they proved, to say the least, partial failures, but it does not by any means follow, that because this was the case, it was the fault of the system.

In India, the earth closet has been used for many years, and in barracks, in jails, and in hospitals it has met with general success. It must, however, be remembered—and this is a fact likely to be overlooked by earth closet enthusiasts—that excremental matters are not the sole nuisances to be got rid of, and that the use of earth involves the employment and the carriage of a large mass of material, which, to say the least of it, would become embarrassing if it was adopted in towns. In public buildings, however, in villages, and under exceptional circumstances in towns, Moule's closet has passed beyond the phase of experiment, and has been proved a success; besides the fertilised but innocuous earth commands a fair sale, and in most cases where it has been tried, the result is a mild commercial success. On the other hand, the objections well-sustained against it, especially that referring to its powerlessness to reduce contagion, despite its deodorizing qualities, are very serious. Altogether it may be justly assumed that the earth closet systems, Moule's or otherwise, are good within certain limits, but that when it is attempted to push them past these limits much harm will result.

The second or water-closet system, appears to be the one best able to meet the requirements of large towns. Properly carried out, it has these great advantages, that no accumulations, deodorized though they be, can accumulate, that derangement is less likely to ensue, and that no inconvenience of house to house visitation is inflicted, to say nothing of the collateral blessing—a good water supply. On the other hand, in winter, great nuisances may occur from the freezing of the water-pipes, and in poor localities a frequent inspection appears almost necessary in any system, to insure its proper working. Of course, besides this, there is the additional difficulty of utilisation, on account of the sewage being mingled with so large a proportion of water; but even here it must be remembered, that though a vast mass of fertilising agents disappears from our view year by year, representing an enormous money value, they are not really lost, but will be utilised in future ages. At the same time there is the serious difficulty that there are many towns so situated that they have no fit point of discharge, and grave accusations are being brought against London even in this respect, that the Thames is silting up on account of the discharge into it.

After some practical and valuable remarks on the construction of sewers for performing their comprehensive duty, in the arrangement of service drains, closet fittings, and water connexions, Mr. Corfield proceeds to dwell upon the sanitary results obtained by the introduction of the water-closet system. Mentioning several towns, he shows that the rates of mortality in various diseases has been considerably lowered by the use of water-closets, and that in typhoid fever especially, the reduction has been marvellous in some places, and marked in all, and not only are the death rates reduced by the decrease of epidemic and infectious diseases, but in pulmonary complaints, a visible improvement results, owing, says Dr. Buchanan, "to the drying of the soil, which has in most cases accompanied the laying of main sewers in the improved towns."

With such results as these, it is surely evident that the water-closet system combined with proper inspection and good water supply, fulfils the most urgent requirements of the time. By its adoption, disease is checked and life lengthened, and though enormous masses of sewage are discharged into the sea annually, representing a vast yearly loss, this loss is more than compensated by the saving and extension of human life. Much, very much, remains still to be done in this direction; to remove the causes of disease from crowded centres is the first duty, the solution of the problem how to utilise the diluted impurities afterwards may well take a second place, and wait the time when the first question shall have been satisfactorily answered.

NOTES FROM THE SOUTH-WEST.

Taff Vale Railway.—The employés in the locomotive department of the Taff Vale Railway have signed a requisition praying that their hours of labour may be reduced to nine per day. Mr. B. T. Fisher, the superintendent, has promised to lay the requisition before the directors to-day (Friday). A similar request is about to be made by the employés of sundry other large works in the neighbourhood.

South Wales Coal.—At the last monthly meeting of the Cardiff Chamber of Commerce, the navy coal returns, August, 1871, were laid upon the table; and the chairman (Lieut.-Colonel Hill) observed that recent trials of South Wales and North country coal had resulted satisfactorily as regarded the quality of South Welsh coal. In 1854 he had a conversation with a friend who commanded a large steam frigate—a vessel of some 500 horse power—and he asked the naval officer's opinion as to the different qualities of the two coals. The naval officer replied, "It is just exactly this: when my bunkers are filled with North country coal, I steam seven days, whereas when they are filled with your steam coal, I steam ten days." The chairman added that the experience to be gathered from the present navy coal returns was to the same effect.

The Forest of Dean.—The coal trade of the Forest of Dean is in a healthy state, and enhanced prices have been obtained. The pig iron trade is equally active, deliveries being large, while prices are tending upwards, as the demand exceeds the supply. The tin works at Parkend, held by Messrs. Allaway for many years, are in the market, and are likely to change hands. The various projects for bridging the Severn are, of course, watched with some interest in the Forest of Dean.

Railway Union.—Among the Parliamentary notices issued on Friday, was one of the greatest importance to the whole western district of England. A Bill is promoted jointly by the Great Western, London and South Western, Bristol and Exeter, and South Devon Companies, including all their branches and tributaries. The notice is ostensibly for a Bill to enable these hitherto competing companies to make full arrangements for interchange of traffic, adjustment of tariffs, &c. The arrangements seem to point to a practical or ultimate amalgamation.

State of Trade at Merthyr.—Trade at Merthyr and in the surrounding district continues active. The output of coal is gradually increasing. The iron works are also steadily employed, a large amount of business passing in rails. Stocks of iron are being reduced, so good and so sustained is the demand.

Midland Railway.—The branch of the Midland Railway from Yate to Thornbury is now so nearly completed, that an engine with a few trucks attached made a trial trip over it on Thursday in last week. Mr. J. Baylis, of Liverpool, has been contractor for the works.

Iron-making at Pontypridd.—The extensive blast furnaces, known as the Forest furnaces, which were erected at Treforest some years since, have recently changed hands. They were erected by Mr. F. Crawshay. Some gentlemen largely interested in the iron trade have now associated themselves together, and have effected a purchase from Mr. Crawshay of the furnaces, together with a considerable tract of land adjoining. The furnaces are expected to be shortly put in blast.

New Steam Line from Bristol.—It is understood that a company is being formed, under favourable auspices, for the establishment of a line of first-class steamers between Bristol and sundry United States ports.

Severn and Wye Railway and Canal.—The report of the directors of this company states that the revenue of the undertaking has been rather prejudicially affected by recent colliery strikes in Dean Forest. The new lines of the company authorised by its Act of 1869 are now rapidly approaching completion. The works of the Lydbrook extension will be proceeded with immediately the requisite arrangements have been made with the Crown and other landowners. The improvements at the harbour are making satisfactory progress, and, when completed, will afford accommodation for larger craft.

Bridging the Severn.—Details have already been given with respect to the scheme for carrying a line from South Wales to Southampton. The second of the Severn railway schemes is called the Western Junction Railway, and the promoters will seek for running powers over a portion of the Severn and Wye line; they propose further to take in Coleford and Newland, and, after crossing the Severn, to take a direct course to Bristol and Bath. They propose further to use the Forest Central line and to branch into the Bullo line. The third of the Severn railway schemes seeks for powers to cross the river by a single bridge, and to make a short branch from the Severn and Wye line to the Wheel Rock or thereabouts, from which it is proposed to commence the span.

The Regulation of Mines.—Mr. Marling, M.P., has promised that a Mines Regulation Bill shall have his best consideration and attention when it comes on in the House of Commons. He considers that such a Bill as the Factory Act was wanted, and he hopes that in discussions upon the subject moderation and good sense will characterise both workmen and masters.

Carmarthenshire Mineral Railway.—This project is expected to be brought under the attention of Parliament in the ensuing session. It aims at the construction of a railway from Pontardulais through the important lime district of Llangendeirne and Porthyrhyd and the rich mineral country of the Great Mountain to Carmarthen.

Iron for the United States.—The Il Leone has cleared from Cardiff for New York with 500 tons of railway iron supplied by Mr. B. Crawshay. The Venuvio has cleared from Newport for New York with 702 tons of iron supplied

THE ROAD STEAMER "RAVEE."

We have been favoured by Lieutenant Crompton with the subjoined abstract logs of the journey lately made by the road steamer "Ravee" from Ipswich to Edinburgh and back. The "Ravee" is one of the road steamers made by Messrs. Ransomes, Sims, and Head, of Ipswich, for the Indian Government steam train, and it is similar in general arrangement to the "Chenab," which attained such an unenviable notoriety at Wolverhampton during the meeting of the Royal Agricultural Society in July last. Instead, however, of being provided with a Thomson "pet" boiler, as was the case with the "Chenab," the "Ravee" is fitted with a Field boiler having 50 square feet of heating surface in the firebox, and 127 square feet in the Field tubes, or 177 square feet in all. The grate surface is 11.25 square feet, the boiler being intended for burning wood, but during the trials, of which the results are recorded below, coal was used as fuel, and the grate area was reduced to 7.6 square feet by placing firebricks in the centre. Inasmuch as the boiler was proportioned for burning wood its performance with coal cannot be taken as a fair criterion of its evaporative efficiency; but we should nevertheless remark that during the trip the boiler was found to maintain an ample supply of steam.

The "Ravee" has two cylinders 8 in. in diameter with 10 in. stroke, and is provided with two ratios of gearing, the fast speed being 3¾ to 1, and the slow speed 12 to 1. The driving wheels are 6 ft. in diameter, and in front there is a single steering wheel, all the wheels being provided with india-rubber tyres. The workmanship of the engine is most creditable throughout, but of the design—for which we believe Mr. Thomson is responsible—we certainly cannot speak in terms of praise. We have, however, no intention of entering into a detailed criticism of the engine here, and we will therefore merely record our opinion that the design of the "Ravee" and her sister engines is very far from being that most suitable for the work these engines are intended to perform.

During the trip from Ipswich to Edinburgh and back, the "Ravee" hauled behind it the two-wheeled omnibus, which was attached to the "Chenab" when the latter engine was at Wolverhampton, the wheels of this omnibus having india-rubber tyres. The "Ravee," in working order, weighed nearly 14 tons, and the omnibus from 5 to 6 tons, according to whether coals and the shoes for the engine wheels were carried in it or not. The average gross weights of the train for different portions of the journey are given in the subjoined Tables. The only casualties of importance were the bending on two occasions of one of the connecting rods, and the complete failure of the india-rubber tyre of the engine leading wheel. Inasmuch as this tyre cost some 40*l.* or so, its failure, which took place before reaching Doncaster, on the down journey, was a serious matter. A stop of several days, for a new tyre, was made at Azerley, and after this tyre had arrived, a further stop was necessitated from stress of weather. The failure of the tyre is attributed to imperfect vulcanisation, gas being generated in the body of the india-rubber, and the tyre being completely distorted in form. A temporary relief was effected by puncturing the tyre to permit the escape of the gas, but ultimately the tyre had to be removed as useless. In publishing the subjoined results, we have no intention at present of commenting upon them in detail. Our opinion of road steamers with india-rubber tyres is well known, and we shall merely state that this opinion has been in no way modified by the performance of the "Ravee." Nevertheless, the subjoined particulars of the journeys made by that engine are, as a record of facts, of very considerable value, and Lieutenant Crompton deserves the thanks of all interested in the use of steam on common roads for having laid them before the public.

TABLE I.—Summaries of Journey from Ipswich to Edinburgh, on September 15, 16, 18, 19, and October 1, 2, 3, 4, 1871.

	Ipswich to Edinburgh.	Ipswich to 40 ft. river.	40 ft. river to Wansford.	Wansford to Doncaster.	Doncaster to Azerley.	Azerley to Darlington.	Darlington to Wooler.	Wooler to Edinburgh.	Most economical run from Ripon to Darlington.	Average performance with shoes on.	Average performance without shoes on.
Total fuel consumed in lbs. ...	29,148	7,392	1,792	4,704	3,052	2,016	5,488	4,704	1,568	18,696	10,452
Total water evaporated in lbs.	137,850	28,500	8,900	21,150	16,400	10,650	27,500	24,750	8,750	86,250	51,870
Total distance traversed in miles	422.5	69	20	83½	53	40	78	70	35	220	193.5
Time actually travelling ...	77 hrs. 26 m.	12 hrs. 9 m.	4 hrs. 10 m.	10 hrs. 25 m.	9 hrs. 28 m.	5 hrs. 22 m.	18 hrs. 45 m.	16 hrs. 58 m.	4 hrs. 17 m.	51 hrs. 1 m.	26 hrs. 55 m.
Engine standing under steam	72 hrs. 23 m.	11 hrs. 51 m.	5 hrs. 26 m.	7 hrs. 30 m.	6 hrs. 40 m.	5 hrs. 8 m.	20 hrs. 15 m.	15 hrs. 32 m.	2 hrs. 58 m.	...	...
Average speed in miles per hour	5.45	5.67	6.8	8.016	5.59	7.453	4.16	4.11	8.5	4.4	7.1
Gross load	19 tons	19 tons	19 tons	19 tons	19 tons	19 tons	19 tons	19 tons	19 tons	19 tons	19 tons
Mile tons	8027.5	1311	551	1586.5	1007	760	1482	1330	665	4551	3676.5
Pounds of coal per ton per mile	3.631	5.638	3.25	2.96	3.00	2.65	3.70	3.53	2 36	4 29	2.87
Water per ton per mile ...	17.17	21.739	16.15	13.33	16.28	14.01	17.9	18.60	13.1	19.8	14.0
Pounds of water evaporated by 1 lb. of coal.	4.729	3.85	4.96	4.5	5.37	5 28	5.01	5.26	5.7	4.61	4 91

TABLE II.—Summaries of Journey from Edinburgh to Ipswich, on November 1, 2, 3, 4, 7, 8, 9, 10, 1871.

	Edinburgh to Ipswich.	Edinburgh to Kelso.	Kelso to Morpeth.	Morpeth to Darlington.	Darlington to Tanfield.	Tanfield to Doncaster.	Doncaster to Grantham.	Grantham to Wansford.	Wansford to Ipswich.
Total fuel consumed in pounds	25,312	3,584	3,920	3,584	2,464	3,584	2,240	2,240	3,696
Total water evaporated in pounds ...	144,300	18,400	20,630	20,850	14,300	21,150	13,250	11,650	24,150
Total distance traversed in miles	424	45	61	48	35	59	53	27	96½
Time actually travelling	61 hrs. 18 m.	7 hrs. 42 m.	9 hrs. 5 m.	9 hrs. 19 m.	5 hrs. 32 m.	8 hrs. 37 m.	5 hrs. 36 m.	5 hrs. 31 m.	9 hrs. 51 m.
Engine standing under steam	42 hrs. 3 m.	6 hrs. 33 m.	5 hrs. 28 m.	6 hrs. 11 m.	3 hrs. 13 m.	5 hrs. 58 m.	2 hrs. 49 m.	4 hrs. 47 m.	7 hrs. 24 m.
Average speed in miles per hour	6.9	5 84	6.71	5.15	6.33	6.85	9.46	4.9	9.63
Gross load	20 tons	19.6 tons	19.6 tons.	19.6 tons.	20 tons.	21.5 tons.	20.75 tons	20.75 tons	20.5 tons
Mile tons	8480	882	1195.6	940.8	700	1268.5	1099.75	560.25	1957.75
Pounds of coal per ton per mile ...	2 98	4.06	3.27	3.80	3.52	2.825	2.03	4.00	1.88
Water per ton per mile	17.01	20.84	17.18	22.16	20.43	16.67	12.04	20.79	12 33
Pounds of water evaporated by 1 lb. of coal	5.7	5.13	5.24	5.81	5.8	5.9	5.91	5.20	6.53

by the Blaenavon Iron Company. The Zanrock has cleared from Newport for New York with 750 tons of iron supplied by the Blaenavon Iron Company. The A. O. Vinge has cleared from Cardiff for New York with 480 tons of railway iron supplied by Messrs. Guest and Co. The Stormy Petrel has cleared from Cardiff for Charleston with 694 tons of railway iron supplied by Messrs. Guest and Co.

The Forest of Dean Colliers.—A series of meetings of colliers has been held at various places in the Forest of Dean under the auspices of the Amalgamated Association of Miners. It was urged at these meetings that as long as 180 members of Parliament were coal and iron masters no good Mines Regulation Bill would be passed until representatives of the miners were returned to Parliament.

The Docks at Avonmouth.—It is stated that Mr. Brunlees, the engineer of the Midland and Great Western Clifton Junction Railway, and also of the Channel docks, was much gratified on a visit to Bristol last week to inspect the works, with the progress which had been made with both undertakings. The excavation at the docks now amounts to nearly 1,000,000 cubic yards.

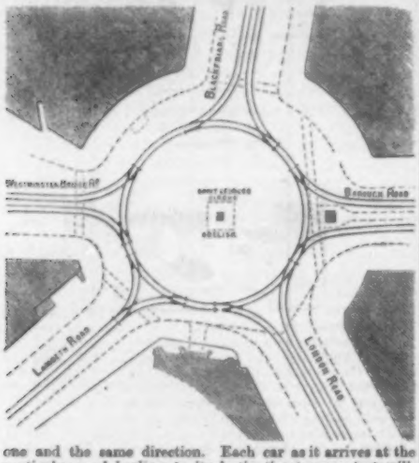
Iron Ore Companies.—We notice that the prospectuses for two new iron ore companies are before the public. The Bilbao Iron Ore Company, with a proposed capital of 500,000*l.*, in 10,000 shares of 10*l.* each, seeks to acquire concessions from the Spanish Government near Bilbao in the Province of Biscay, for working the same, and for constructing the necessary railways in connexion with the mines. The prospectus states that the richest mine of the group, that of Galdames, has a length of 1200 yards, a height of 170 yards, and an unknown depth. The amount of ore contained is estimated at many millions of tons. Analyses would show the quality of the ore to be excellent, containing 50 or 60 per cent. of metallic iron, and approaching in composition to the Cumberland hematites. The cost for extracting the ore, and loading it in trucks alongside the mines is estimated at 9d. per ton, and the price on board at Bilbao, including royalties, at 4d. per ton. Freight to South Wales being 10s. per ton, the ore would be sold here at 18s. a ton, with a large profit, and so far beneath ruling prices as to insure a large demand. With an annual shipment of 500,000 tons a profit of 20 per cent. would be realised upon the capital invested. It may be remarked that only 5000*l.* are to be paid to the vendors. The second company is the Leicestershire Ironstone and Smelting Company, with a proposed capital of 200,000*l.* in 10*l.* shares. The object of the company is to purchase about 1000 acres of freehold land near Market Harborough, in Leicestershire, for working and smelting the ironstone on the estate. This ironstone, which, according to the engineers' report, contains from 33 to 40 per cent. of metallic iron, exists to the extent of 16 millions of tons, and would realise a profit of from 2s. to 2s. 6d. per ton. The income of the company would be realised from the sale of the ore, 150,000 tons per annum realising 15,000*l.*, from smelting an equal amount worth 37,500*l.*, and from the rental of the arable lands, 2000*l.* being estimated as the value of this last item. Gravel, sand and brick earth abound in the estate, and would be utilised in the construction of works of the company. The company propose to purchase the estate for the sum of 110,000*l.* in cash and 28,000*l.* in shares, leaving a capital which is considered ample for working the mines. We are informed that the company has already received very favourable offers for the whole of the pig iron they can produce during the next two years. The shares are now quoted at ½ to 1 premium.

LONDON TRAMWAYS.

To the Editor of Engineering.

Sir,—The tramway system for the conveyance of passengers through the thoroughfares of the metropolis is (although only in its infancy) now so far an accomplished fact, that the public are enabled to express a decided opinion of its merits and demerits, and if we may take as a criterion the extensive use made of the few lines now completed, the comfort, convenience, and economy of this mode of conveyance, is as highly appreciated by the travelling public in and around London as is the case in continental cities and in the United States, where it has had a far more extended trial. On the south side of the Thames the system is perhaps rather more developed at the present time than on the northern side. East Greenwich is connected with Blackfriars Bridge, Westminster Bridge, Kennington, Brixton, and Clapham, and will shortly be joined up with Vauxhall Bridge, by the more direct route of Peckham and Camberwell.

The most interesting part of the system is at the junction of the several roads running into and out of the St. George's-circus in the Blackfriars-road. The method adopted here secures a perfect junction of all or each of the routes, and that with only a single line of rails running round the circus, thereby doing away entirely with a great quantity of rails laid in the roadway, which would of necessity have been the case had the several double lines of road been carried across each other, necessitating as it would have done a great number of points, crossings, &c., all massed in one place. The accompanying sketch represents the arrangement of the junctions and the direction of the traffic, by which it will be seen that both the up and down traffic when entering on and travelling round any arc of the circle or single line laid round the circus must of necessity travel in

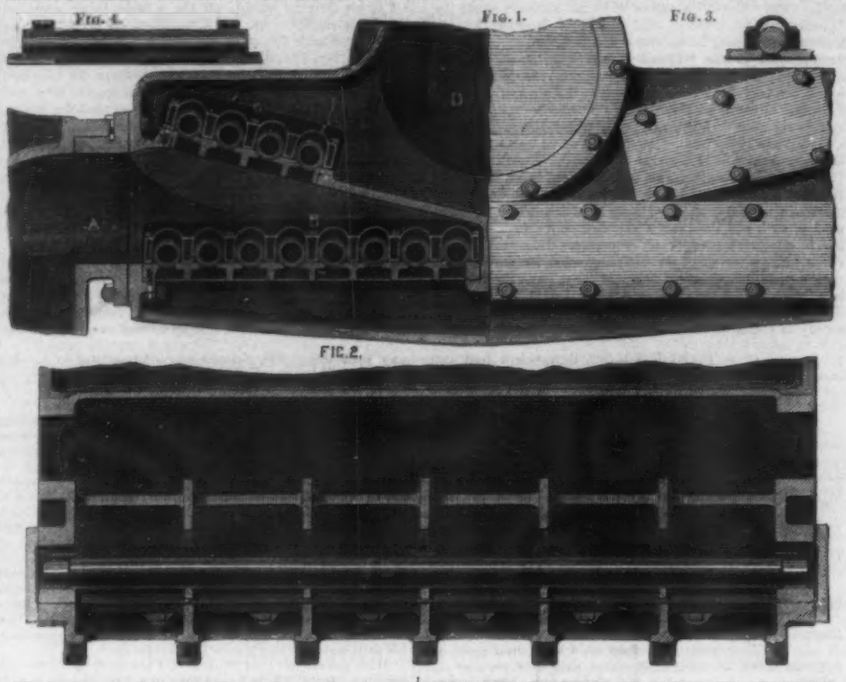


one and the same direction. Each car as it arrives at the particular road leading to its destination turns out at will, and leaves the car following to continue round to whichever road may be its proper route. By this arrangement the chances of a block are reduced to a minimum, such a thing being indeed impossible except in the case of a breakdown. The method of joining the several roads here adopted is such that an almost unlimited amount of traffic can be carried over it without in any way impeding the general traffic of the roads. As, unlike any system of lines crossing each other, the cars are continually moving, there cannot ever be a necessity for one or more cars to wait for another to pass, the direction of all being the same, namely, from right to left. At the present time a car passes round a portion of the circle to some one or other of the several roads about every half minute, yet the most strenuous opponents to the system cannot ever point out anything approaching to a block at these junctions. In conclusion, I have only to say that if the several difficult points which will doubtless be met with in carrying out an extended system of tramways for the metropolis are all as successfully overcome as in this particular case, this method of public conveyance will become even more popular than it is at present, and now it is so highly appreciated by business people and others that in one case it has made a traffic of its own previously non-existent, viz.: where an omnibus formerly was scarcely able to exist by running once an hour from East Greenwich, a car is now despatched every five minutes, and secures a sufficiency of passengers.

Yours obediently,
J. D. Larsen.

Metropolitan Improvements.—The metropolitan Board of Works intend to apply to Parliament for powers to effect improvements in the following localities, either by widening the existing principal thoroughfares or constructing new streets:—High-street and Lower East Smithfield, Wapping; High-street, Shoreditch; Old-street, towards New Oxford-street; Harrow-road, and Newington Butts. It is also proposed to widen Serle-street and effect improvements near that street and Cook's-court. Parliament will be asked in the ensuing session to authorise the construction of a subway under the Thames, commencing at the south-west corner of the ornamental ground adjoining the Victoria Embankment, and immediately to the eastward of the Temple station of the Metropolitan District Railway, and terminating on the opposite side of the river near the junction of Princes-street with the Commercial-road.

HARGREAVES AND INGLIS'S VALVES FOR BLOWING ENGINES.



We lately noticed in our "Recent Patents" a form of valves for blowing engines designed and patented by Mr. William Hargreaves and Mr. William Inglis, of Bolton; and we now publish engravings of these valves showing the mode of applying them. The valves consist of hollow metal cylinders covered with vulcanised india-rubber, or some equivalent elastic substance, and placed so as to close elongated rectangular openings, as shown. The lift of the valves is governed by suitable guards, and when necessary the seats are made concave, as shown in Figs. 1 and 3, so as to give the valves greater bearing area. Figs. 1 and 2 show the valves arranged as Messrs. Hargreaves and Inglis propose to apply them to a pair of blowing engines delivering blast into the same main; the left-hand or sectional half of Fig. 1, showing the valves for one end of the cylinder of one engine. In this case, A is the passage communicating with the cylinder, B, are the suction valves, and C the delivery valves, while D is the blast main. It will be seen that the arrangement is such as to give ready access to the valves by removing the end covers of the valve chests. In Figs. 1 and two the valves are shown made so that each cylinder extends over a series of openings separated by narrow supporting ribs; while the guards also are each made to extend over a number of cylinders. If desired, however, the valves can, of course, be made in short lengths with independent guards, as shown in Figs. 3 and 4. The valves we have described appear to us to promise well, and we shall be glad to have particulars of the results obtained with them in practice.

NARROW GAUGE RAILWAYS.

To the Editor of Engineering.

Sir,—In an article on "Narrow Gauge Railways" in your paper of the 3rd of this month, when treating on the subject of breaking bulk, you estimate the cost of transshipment necessitated by a break of gauge at 1½d. per ton. In the evidence given before the commissioners appointed to inquire into the subject of railway gauge in 1846, the cost was estimated at 1s. per ton and the damage at 2s. 6d. per ton. Perhaps some of your readers connected with the Great Western or other railway company would publish the actual cost of transshipment at the present time, as this item is of great consequence in deciding upon the question of a break of gauge.

Yours obediently,
November 22, 1871. G.

[The gentlemen who gave the evidence quoted by our correspondent must have forgotten the "break of gauge" which occurs when the goods to be carried by rail are transshipped from the ordinary road carts and vans to the railway wagons and *vice versâ*. The cost of transferring the goods from one railway wagon to another of a wider or narrower gauge certainly cannot be more, and in most cases probably would be much less, than that of loading the same goods into ordinary road vehicles. The estimates of 1s. per ton for transshipment and 2s. 6d. per ton for damage are simply absurd.—Ed. E.]

The Suez Canal.—The revenue of the Suez Canal Company in October was 50,526*l.*, as compared with 22,167*l.* in October, 1870. To the total of 50,526*l.* collected in October what is termed the "maritime movement" contributed 40,965*l.* The number of ships passing through the canal in October was 79, as compared with 30 in October, 1870.

THE INSTITUTION OF CIVIL ENGINEERS.

To the Editor of Engineering.

Sir,—I enclose to you, for publication, the following lithographed letter, which is now being circulated:

Offices, 7, Westminster Chambers, Victoria-street,
Westminster, November 1, 1871.

Sir,—The expiration of a valuable patent, and the cessation of the *Practical Mechanics' Journal*, of which for several years I have been the editor-in-chief, afford me leisure which I desire to employ by increasing my practice as a consulting engineer, and as a skilled witness in legal or other cases demanding reports or testimony of a scientific and practical character.

Educated, after university training, as a civil and mechanical engineer, I became the sole managing partner, for above twenty years, of large engineering works created by my father and myself. Afforded thus the advantages of a wide and varied practice, with a strong natural liking and ample means for experimental research—mechanical, physical, and chemical—I may venture to affirm that no member of the engineering profession has acquired a larger or more varied and exact knowledge of technology: the proof of this is best seen in my various published works and memoirs.

Other qualifications, however, besides these are required to constitute a reliable and impressive scientific witness. A logical and consecutive habit of thought, order and lucidity in expression, whether in written reports, *ex*, *viva voce*, and in court; a competent knowledge of Patent Law and procedure of contracts, &c., and a sound judicial judgment in arranging and marshalling scientific matter for use of counsel are almost equally necessary.

How far I have been enabled to bring such to the service of my clients, the subjoined list of important causes, amongst many others, in which I have within a few years been engaged, will best testify. I possess an excellent analytical and physical laboratory, a large technological library, am well acquainted with foreign technical literature and science, and am accustomed to chemical and metallurgical investigation; these have often proved specially serviceable to clients in whose cases I have been engaged.

In point of professional and social position, I am a member of the Institution of Civil Engineers, Past-President of that Institution and of the Royal Geological Society in Ireland, a Fellow of the Royal Society, of the Geological Society of London, of the Northern Mining Institute, and of various other British and foreign academies or scientific bodies, from many of which I have received medals and other honours.

I have always declined to engage in any case where I had any doubt that right and truth were not on the side of those seeking my services, hence I have been always able to throw my whole knowledge and energies into the cause of my client, and preserved that untarnished reputation which is the foundation of impressive testimony before courts or public bodies.

I shall be glad, if you should think fit, in the course of your professional practice, to afford me some occasions for proving to you the validity of the above statements, made under the disadvantage that always attends the man who has to bear witness as to himself.

I am, Sir, your obedient Servant,
(Signed) Robert Mallet, A.M.

Of the good taste of this production I say nothing, but I desire to call the special attention of my fellow-members to the following passage: "I am a member of the Institution of Civil Engineers, Past-President of that body." Mr. Mallet was elected an associate of the Institution on the 12th of March, 1839, and was made a member on the 14th of June, 1842, but he has never been elected President of the Institution, nor has he ever even held a seat at the Council; his statement, therefore, calls for an immediate and full explanation.

Yours obediently,
A Member of the Institution of Civil Engineers.
London, November 22, 1871.

BERRYMAN'S STEAM-TRAP.

CONSTRUCTED BY MR. J. IRELAND, ENGINEER, MANCHESTER.

FIG. 1.

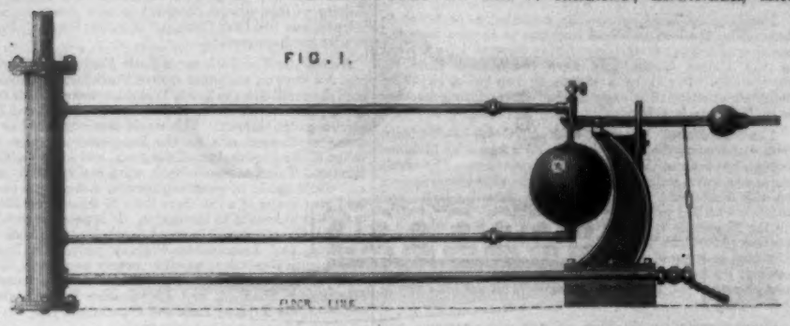


FIG. 2.

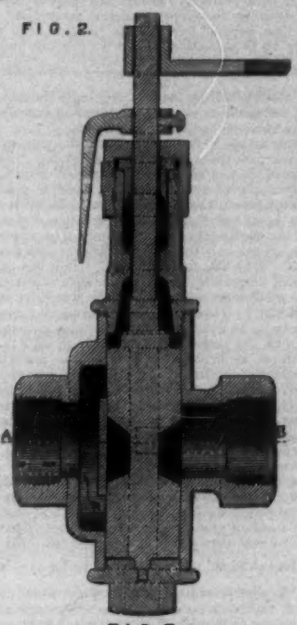


FIG. 3.

A FEW weeks ago we illustrated Berryman's feed water regulator for steam boilers, and we now publish engravings of a modification of this arrangement applied as a steam trap. As will be seen by Fig. 1, the apparatus consists of a large hollow ball connected to the steam pipe to be drained by two horizontal pipes, these latter pipes being of such length as to possess sufficient elasticity to allow the ball to move up and down through a short range. The weight of the ball is supported on V-centres which rest on the shorter arm of a weighted lever as shown, the other end of this lever being coupled by a rod, to the arm of a stop-cock fitted to a third pipe leading from the lowest point of the pipe to be drained.

The action of the apparatus is very simple. As water collects in the steam pipe it gradually fills the hollow ball until at length the latter overbalances the weight at the other end of the lever by which it is supported; and by descending opens the discharge cock and allows the water to escape. This being done the ball is emptied, or partially emptied, and being overbalanced by the loaded lever, rises again and closes the stop cock. The stop-cock used is of peculiar construction, and it is shown in the sections Figs. 2 and 3. From these views it will be seen that the water entering the cock on one side of the plug passes upwards and downwards through recesses formed in the latter, these recesses communicating, when the plug is turned, with openings in the case on the opposite side to that at which the water entered. By this arrangement the plug is approximately balanced, and it is found to move very easily and keep tight without trouble. In conclusion we should state that the steam trap we have described, and of the performance of which we have heard good accounts, is being manufactured in this country by Mr. J. Ireland, of Edward-street, Broughton-lane, Manchester.

STEAM ENGINE COEFFICIENTS.

TO THE EDITOR OF ENGINEERING.

SIR,—I really hoped it would not be necessary for me to reply to Mr. Gray's letter in your issue of 3rd inst., trusting that, on calmly reviewing himself in print, he would discover his blunders, and hasten to acknowledge them. That he has discovered blunders his letter in your following issue shows. As he only admits some of them, however, and instead of retracting his expressions, endeavours even to make capital to himself out of his own blunders, I cannot allow the matter to pass without a final review.

Regarding Mr. Gray's last letter, which is written on discovering the accuracy of my corrections, it is really amusing to see the miserable shifts to which he resorts in order to throw the burden of blunders off his own shoulders on to mine. There is no need to refer further back than the paragraph itself in which the blunders are exposed to find that there is no excuse for him, and that the point was taken up solely in answer to Mr. Gray's challenge of *accuracy to the last decimal place*. He explains now that, believing me consistent, he did not think it necessary to verify my figures. Well, if he did not verify my figures, he surely did try to verify his own, seeing that he sounded the challenge so gaily again, and "with the greatest pleasure," yet he could not alter the value of the result, although, as he himself admits, it was only the Rule of Three that was involved. Take again the calculations immediately preceding the one dealing with the challenge where Mr. Gray gives himself the following problem to write out: Given the theoretical final pressure 6.125, and the theoretical coefficient 3.2355, to find the theoretical mean absolute pressure. The working man would do this by simple multiplication, $6.125 \times 3.2355 = 19.817$ lb., and would then find the value of the losses called x, by taking the mean actual absolute pressure, $16.167 + 1.5 = 17.667$, and by simple subtraction, $19.817 - 17.667 = 2.15 = x$. Mr. Gray, on the other hand, tries to get the value of x by an extraordinary roundabout method, and based on a supposition as ridiculous as the supposition that 2 and 2 is not 4, the result being that he gets 1.96 lb. as the value of x, instead of 2.15 lb. It was accuracy to the last decimal place that Mr. Gray claims, and now his inaccuracies are to be found even amongst the integers. Let me now here remind Mr. Gray that he has inadvertently neglected to request me *not* to draw my pen through the words he gave in italics; but perhaps, Mr. Editor, you have the request in a telegraphed errata.

Mr. Gray also explains in his last letter the object he had in taking up this subject, and states that "a coefficient above perfection, beyond back pressure, was claimed for the working of these engines, and he began by supposing just such perfection existed." Now I challenge Mr. Gray to find that any such thing was claimed, and on referring to his first letter it will be found that he began by supposing no such thing, but that he began by trying to find what the theoretical coefficient would be for a perfect gas expanded the same number of times as the steam in the diagrams; and independent of the absurdity of comparing a coefficient so obtained with the coefficient given and obtained as you explained, he, as I have shown, even failed to write out the simple problem he gave himself. He then further makes me to say that I asked him to grant cards with 19.563 lb. pressure. This is gross misrepresentation; I asked him to grant nothing of the sort. The cards corresponding with 19.563 lb. pressure were his own ideal gas cards, which he tried to calculate the value of, but failed. I pointed out where his failure lay (a correction for which I have small thanks), but further than this, I had nothing to do with his gas cards. My "simplicity" would be great indeed did I allow such misrepresentation to pass undiscovered. That Mr. Gray's system of coefficients is as grossly erroneous as his arithmetical calculations I will soon show.

With reference to his remark: "I assumed the cards to be genuine cards." This he explains in a previous letter to be cards taken when "the engine is moving at any reasonably uniform speed, and the cards are taken in succession, first, one from the high, then one from high and one from low; then one from low, completing the set in one and three-quarters revolutions." Now as it is simply impossible that such a set of cards could be taken consecutively in one and three-quarters revolutions, however slow the engine was going, we cannot help believing that Mr. Gray never did take, nor has even seen taken, a set of diagrams, and that the conditions laid down on which a set of genuine cards must be taken are the result of a theoretical investigation worked out with Mr. Gray's usual *accuracy*. Now allow me to tell Mr. Gray that a full set of cards might be taken from such an engine in *one* revolution, but on the following conditions only: The cards must be taken simultaneously, and not consecutively, as he would like them. There must be four indicators—the indicator cocks must all be coupled by levers or other gearing to one cock-handle, and even then to insure success I would recommend, as a final condition, that Mr. Gray be in gear with that cock-handle. He specifies an odd three-quarters revolution: this must be to give him time to open and shut the cocks. My engines were making 66 revolutions when the cards were taken; he has therefore a little over half a second for his operations; a trifle more and his cards are spoiled. And allowing him to be successful he will not have obtained the "genuine cards" after all, for he has not got them in the specified order. Now I would like to know how many of your readers have seen cards taken under the above conditions? I will even take off Mr. Gray, and ask if they have ever seen the remaining combination of diagram apparatus? I do not think any one ever has, and it is certain that Mr. Gray never has seen a set of genuine cards if his conditions are the test of their genuineness, because such conditions are absurd and impossible.

Now let me state, regarding the cards under discussion, that they were taken by two indicators—one on each cylinder—and that the full set were taken in about half a minute, and while the engines were certainly running reasonably uniform, at 66 revolutions per minute, as stated on the cards; and under just such conditions as these are a set of diagrams usually taken I think; although, as I previously stated, in the receiver type of compound engine, the diagrams may not show the same steam, nor even necessarily the same weight of steam in both cylinders.

Now Mr. Gray claims to have found my "lost steam." I certainly do thank him for this, and will reward him by showing him how much better it can be employed than in whistling to annoy people. Thus, if the steam did expand, according to Rankine's ninth root formula, then it so happened that the cards really did measure the same weight of steam, and fit each other exactly. It is therefore unnecessary to make any such correction as is required, if the expansion is according to the $\frac{1}{10}$ root formula.

Mr. Gray now finds that the steam neither gained heat from, nor was robbed by, the metal of the cylinder; now this is the highest possible testimony as to the efficiency of the jacketting, for it is the object directly aimed at with the jackets, and it is simply impossible that, in that sense, they could have done better.

Mr. Gray says: "I before gave the coefficient due to expansion under mathematical conditions." "I will now find the coefficient due to the expansion law actually followed in the engine." Now I should just like Mr. Gray to say, if he can, why it is that when the law of expansion is that of constant products, i.e., according to the hyp. log. formula, it has any better claim to be called expansion under mathematical conditions than when it follows the law corresponding to the ninth root formula. It is just on this point that the whole question of the value of these coefficients rests, and it is just here where Mr. Gray makes his grand blunder. Thus in finding a coefficient by the latter formula to compare with the coefficient given with the diagrams he still virtually divides by the terminal pressure 6.125, i.e., the terminal pressure due to a *perfect* gas instead of by the terminal pressure due to the expansion law assumed. It is obvious that such a comparison is absurd. His rule for the coefficient being this: "Divide nine by the ninth root of the ratio of volumes, and deduct the quotient from nine also," when the rule should be: Multiply ten by the ninth root of the ratio of volumes, and deduct ten from the product. This rule will give Mr. Gray a coefficient that he can directly compare with the one given with the diagrams, and yet be a coefficient under mathematical conditions from which he can always deduce, if so minded, the value of the steam before it had parted with any of its energy.

In the case in point Mr. Gray's formula for the total gross coefficient is this,

$$\text{Gross coefficient } 3.2355 = 1 + \text{hyp. log. } 1.882 + 9 - \frac{9}{5.845^{\frac{1}{9}}}.$$

When it should be,

$$\text{Gross coefficient} = 1 + \text{hyp. log. } 1.882 + (10 \times 5.845^{\frac{1}{9}}) - 10.$$

Working out the latter formula we have:

Log. $5.845^{\frac{1}{9}}$	$=\frac{1}{9}$) .706785	
		.085198
Log. 10	=	1.000000
Log. 12.167	=	1.085198 = log. $(10 \times 5.845^{\frac{1}{9}})$
10		
2.167	=	$(10 \times 5.845^{\frac{1}{9}}) - 10$
.6323	=	hyp. log. 1.882
1.	=	effect of admission
3.7993		gross coefficient.

This is the theoretical coefficient due to the law under which the steam expanded. To prove that it is correct, and that Mr. Gray did virtually divide by 6.125 instead of 5.0337—which was the the terminal pressure he found due to that law of expansion—let us take the coefficient he obtained, and inverse the proportion; thus $\frac{(1.6323+1) \times 6.125}{5.0337} = 3.167$. Deducting 1 from this for the effect of admission, we have 2.167, or exactly what is obtained for this part of the expansion from the preceding formula as worked out.

I have shown the gross theoretical coefficient to be 3.7993, this, multiplied by the due terminal pressure, gives $3.7993 \times 5.094 = 19.126$ as the mean absolute theoretical pressure,

and deducting from this the mean effective pressure plus the back pressure, which I will call 1.5 lb., we have 19.126—(16.167 + 1.5)=1.459 lb. as the value of the other losses beyond the back pressure, namely, the value of the losses due to wire drawing, rounding of exhaust corners, &c. And supposing that, beyond having back pressure, the engine was working up to perfection, we get the greatest possible actual coefficient to be $\frac{5.7993 \times (19.126-1.5)}{19.126}=5.5$. This is not a higher coefficient than the 5.93 originally claimed, but represents a difference in excess corresponding exactly, of course, with the value of the losses given above.

In your article of September the 15th, you speak highly of the value of these coefficients as giving "an excellent measure of the amount of work derived from the use of a given quantity of steam," and Mr. Gray, in your next issue, "quite concurs in the opinion given." In his last letter but one, he speaks of these coefficients rather disparagingly, he says, "the coefficients found are only first approximations, and are always only limiting coefficients and always err in excess." Why this inconsistency? Is it because Mr. Gray has failed to establish a claim to have originated them, or that he really does now see that he has been misusing "a good thing"? That he really does misuse these coefficients there can be no doubt, and as a simple illustration of this, let us take the theoretical expansion of 35.8 lb. expanded 5.845 times, as dealt with above. The coefficient for the expansion derived from the due terminal pressure (5.034 lb.) is 3.167, as shown, whereas, according to Mr. Gray's calculation it is 2.6032. Supposing now that the steam instead of being admitted into a jacketted cylinder, where it neither gave to nor took heat from the metal of the cylinder, had been admitted into an unjacketted cylinder, the heat would have been taken up and steam would have disappeared at the beginning of the stroke, but would nearly all have reappeared towards the end of the expansion, and supposing the terminal pressure 5.034, and just as high as that due to the law of constant products calculated from any part of the expansion—and surely that is not supposing too much—the coefficient obtained would therefore be $1+\text{hyp. log.}\frac{35.8}{5.034}=2.96$. So that according to Mr. Gray, when the steam is worked to the greatest possible advantage in jacketted cylinder the coefficient of efficiency is 2.6032, and the same weight of steam when worked under the most unfavourable conditions gives a coefficient of 2.96. Now the coefficients in the two cases are 3.167 and 2.96 respectively, and it is obvious that these coefficients represent with sufficient accuracy the comparative efficiency of the expansion under the different conditions named. If Mr. Gray's method is to be used as a test of the efficiency of engines, manufacturers, instead of barrelling their cylinders, which would be awkward and expensive, should give up steam jackets, an arrangement that they certainly could fall in with conveniently enough.

But Mr. Gray evidently discovered the absurdity of his own method, for he now qualifies the value of his coefficients by saying they have only a limiting value, and now speaks of succeeding steps being required to give them an approximate positive value.

Now there is no need for any further steps to get this. If the actual terminal pressure shown in the cylinder be used as the divisor, the coefficients obtained will afford a sufficiently accurate comparative measure of the efficiency of different steam engines, whether the cylinders be jacketted or not.

Mr. Gray says he gives me my own way when dealing with the curve of saturation, that is, with reference to my assumption that the steam expanded according to the sixteenth root formula, but it will be seen that he does this by a misstatement of the formula similar to that already pointed out. Thus, instead of $17-\frac{16}{11^{\frac{1}{16}}}=3.227$ coefficient, it should be $(17\times 11^{\frac{1}{16}})-16=3.75$.

Another reason Mr. Gray gives in favour of measuring the steam on the high-pressure card has very little force, namely, that the variation of the atmospheric line affects less the accuracy of the calculations. Now there is no need for approximations of this sort, for the reading of the barometer is just as easily noted as that of the vacuum gauge; and this is often done. Some steamship companies have on their printed forms for indicator cards provision made for filling in this.

Yours respectfully,

CHAS. SMITH.

Hartlepool Iron Works, November 22, 1871.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a fair average attendance on 'Change at Middlesbrough. Every blast furnace available is at work, and the production of Cleveland pig is larger than ever. The demand, however, keeps in advance of the increasing power of supply, and consequently prices are better. For No. 3, 60s. per ton is being paid for delivery next year. Prices all round are higher, and makers feel confident that during the next few weeks they will be further advanced.

The Finished Iron Trade.—Beyond the fact that all the departments are fully occupied, and prospects are good, there is nothing to report in this branch of the Cleveland trade.

Shipbuilding.—On the Tyne, Wear, Tees, and Humber there is still great activity in all the shipbuilding yards. Week after week orders for new steamers are being booked, and so quickly as one vessel leaves the stocks, her place is occupied with the ribs of another.

Engineering.—Throughout the North general engineering is in a satisfactory state. For marine engines there is a heavy demand. The locomotive department is good and bridge building is better than it was some time ago. A big bridge for the Dutch Government is now in the market, and hopes are entertained that the contract for building it will be obtained by a Middlesbrough firm.

Puddling by Machinery.—The commission sent out to America by the Iron and Steel Institute to inquire into the working of Danks's revolving puddling furnace, have arrived in the United States, and have commenced their investigations. It will be a month or two before anything definite respecting their experience of the puddling machine is made known in this country.

The Nine Hours' Movement at Middlesbrough.—We learn with satisfaction that the nine hours' question at Middlesbrough has been settled in an amicable manner. The men's notices to leave, unless they obtained the nine hours' system on the Sunderland terms, expired on Saturday last. The masters who had previously conceded the nine hours' system on the Newcastle terms gave the men all they asked. A portion of the men at several of the works took holiday on Monday, and paraded the town in celebration of the concession. Afterwards a mass meeting was held, and they complimented the managers and masters on the kind way in which they had met them on the question.

Improvements on the Tyne.—Great improvements will shortly be made in the dock accommodation on the Tyne. The shipping requirements at that great port are large, and in order to keep pace with the progress of commerce, the Tyne Commissioners have resolved to make a dock at Coble Dene. They have adopted comprehensive plans submitted by their experienced engineer, Mr. Ure, which deals with the undertaking in a masterly manner. The outlay will be enormous, but, considering the position of the port, there need be no apprehension on this score. Certainly when the plans of Mr. Ure, who has done so much to improve the Tyne, are carried out, that river will be second to none in the kingdom.

The Mines.—There is a capital demand for hematites just now. Large quantities of Cumberland ores are sent over to Cleveland, and the importations of Spanish ores are very heavy. In Cleveland the ironstone miners are working well, and the yield is enormous. At some of the collieries in the North there is a movement for working shorter time, but the question will doubtless be easily settled. Coal and coke are in great demand.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Drainage of Lincoln.—Plans of the drainage scheme have been deposited by the engineers who have it in hand, in so far as is legally requisite. Some three or four years ago Mr. Lawson sent in an estimate, which amounted to 49,000*l.*, exclusive of the cost of the land required for irrigating purposes. The present plans are scarcely on as large a scale, and should, therefore, be less costly in execution. The land to be purchased will, of course, always be productive, and worth its first cost.

New Limited Liability Company near Sheffield.—The business until now carried on at Stocksbridge, near Sheffield, by Mr. Samuel Fox, as a manufacturer of steel wire, patent umbrella ribs, &c., has just been converted into a company, with limited liability. The company possesses a capital of 300,000*l.* in 10*l.* shares, and was registered on the 1st inst. There are to be not less than three directors nor more than six, and each must hold at least twenty shares. They are at present Mr. Samuel Fox (the vendor); Mr. Henry Unwin, iron, &c., merchant, of Sheffield; Mr. James Halliday, Manchester; and Mr. Frederick Bardwell, Sheffield. Mr. Fox takes 1000 shares, and is to receive 1500*l.* per annum salary, the other directors receiving 100*l.* per annum each. Bearing in mind the general demand that exists for Fox's "Paragon" frames, it is easy to predict success for the company's operations.

Railway and Dock Accommodation at Grimsby.—On Friday last, about forty of the directors of the Midland, Great Northern, and Manchester, Sheffield, and Lincolnshire Railway Companies, visited Grimsby. It is understood that their object in so doing was to arrange on the spot mutual railway and dock accommodation, so as to afford equal and ready facilities for managing their respective traffics. I am not positively informed that this desirable object was attained, but if so—which is to be hoped was the case—it will undoubtedly give Grimsby a great stride forward, and rapidly hasten the time when that town will be regarded as the Liverpool of the east coast.

New Railway in North Lincolnshire.—A new line of railway is to be formed between Wainfleet on the North Lincolnshire coast, and the Firsby station of the Great Northern East Lincolnshire line. The Great Northern will work the line, which will be comparatively easy of construction and inexpensive.

Doncaster Water Supply.—Notice is given of an intention to apply to Parliament for the incorporation of a company to supply Doncaster, and the adjoining villages of Conisboro', Warmsworth, Balby-with-Hexthorpe, &c., with water. The storage reservoir is proposed to be made at Hooton Brook, and the service reservoir for Doncaster (near Tenter-lane. The promoters, somewhat singularly, ask for powers to buy from the Doncaster corporation the new existing water works in Frenchgate. The town council will oppose the scheme, which will cost, if carried out, about 40,000*l.* Messrs. Baxter, Rose, and Norton, of Doncaster and London, are the solicitors for the promoters.

The Monkwood Colliery near Sheffield.—The Monkwood Colliery, which some time ago passed into the hands of an industrial partnership after the manner of Messrs. Briggs, of Whitwood, has lately been remodelled by a local engineer. At the old shaft two 12 horse power engines have been put down for pumping purposes, and for drawing up corves on the incline of the deep coal bed. At least 200 tons per diem can now be raised at each shaft. The Midland line passes the colliery at a slight distance. The management of the colliery has recently built a number of first-class cottages for the accommodation of the workmen. The coalfield in the vicinity of this village (Barlow) is now being rapidly developed, and like Clay Cross and Staveley, the place begins to lose its rural appearance.

Notices for New Railways in South Yorkshire.—During the past few days an abundant crop of Parliamentary notices has been showered down in South Yorkshire, some of their features being peculiar. A useful project is the Sheffield and Buxton narrow-gauge railway. This would leave Sheffield at its extreme north-west side on the Langsett-road, pass up the valley of the Rivelin, tunnel the Peak, and so by Castleton to Buxton. This line would open up some splendid scenery, and would not be of great engineering difficulty. The Midland give notice of a line from their Worksop and Mansfield branch at Shirecaks to Doncaster. It is needless to add that the Great Northern will oppose this scheme. The Manchester, Sheffield, and Lincolnshire Railway propose a line from Worksop to Doncaster, which is nearly parallel to the Midland proposed route at but two or three miles distance. The Manchester, Sheffield, and Lincolnshire Railway also give notice of the Kiveton Park and Chesterfield line, the course of which I have previously detailed.

The Sheffield Tramway Schemes.—Two tramway schemes are announced for Sheffield. The Corporation of that town, as already mentioned in our columns, seek powers to construct one line of tramways to Attercliffe, &c. The other scheme propounded by a company, also projects a line along the route proposed to be occupied by the Corporation, and in addition eight other lines, in various parts of the town, so as to occupy the whole of the available ground. The Sheffield Corporation also go to Parliament this Session for powers to purchase the Water Works Company of that town, and to pay the costs incurred by them in the attempt for the same end in 1870.

Removal of Telegraph Business at Sheffield.—On Saturday night and Sunday last the whole of the instruments, testing apparatus, &c., employed by the telegraph department at Sheffield, were removed from the old office to the new post office. The former office had been in use for telegraphic purposes since the year 1845.

FOREIGN AND COLONIAL NOTES.

Coal in Virginia.—As an illustration of the still dormant coal wealth of Virginia it is stated that the Chesapeake and Ohio Railroad has been cut for a considerable distance through a vein of coal, 11 ft. thick. There are also great beds of ironstone in south-western Virginia.

Central Railroad of New Jersey.—This line has been double-tracked from Somerville to Jersey City, and the laying of two more tracks will soon be commenced. The whole line is now being laid with steel rails.

The Messageries Maritimes.—This company, formerly known as the Messageries Impériales, and the affairs of which were discussed in some detail in a recent number of ENGINEERING, has declared an interim dividend for 1871, at the rate of 12*s.* per share. This dividend will be paid December 1. The 20*l.* shares of the company now stand at a little over 22*l.* each.

Midland Railway of Canada.—This line, it is stated, is about to be extended to Hog Bay. There is nothing at present at Hog Bay to tempt a railway. But Sir Hugh Allan, of Montreal, proposes to put on a line of steamers at an early date to run between Hog Bay and Chicago and, other ports on the upper lakes. This scheme, if carried out, may prove a powerful rival to the Collingwood route.

Immigrants into the United States.—The number of immigrants who landed at the port of Boston during the year ending October 1, 1871, was 22,904. Fewer immigrants now land at New York than formerly; the steam lines to Montreal, Boston, and Baltimore, have diverted the current of travel.

The Belgian Coal Trade.—In consequence of the great want of coal trucks experienced upon the Belgian State Railways, 800 trucks capable of carrying 10 tons each have been specially ordered for this department of the traffic upon the system. Several engines have also been ordered to provide for the traction of additional coal trains.

Russian Defensive Preparations.—The citadel of Samarcand is being strongly fortified, and the compass of its walls contracted in such a way as to admit of its being defended by a single battalion. Small hill forts are being erected here and there along the southern slope of the Caucasus. The collection of material for a Nicholaieff flotilla has been pursued with vigour. New batteries at Cronstadt are being protected by shields of armour-plating along their seaward front, and so on.

Coal in Victoria.—Coal is stated to have been discovered near Geelong in Victoria. The quality is good, but the site where it was found has not been made public. Some good gas was made from this reputed Geelong coal. The Victorians are anxious to discover a payable coalfield as they now have to import large quantities of New South Wales coal.

Alpine Railways.—It is stated that contracts for the construction of a railway over the Splugen Pass have been entered into at Bâle.

Dock Accommodation in Port Jackson.—At the last meeting of the Sydney Chamber of Commerce, the members took into consideration the importance of a larger dry dock in Port Jackson, and it was decided that a deputation should wait upon the New South Wales Government to draw its attention to the matter. Should the Government determine to construct an efficient dock, it must be prepared to face an expenditure of not less than 100,000*l.*

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NOTICE OF MEETING.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, November 28, at 8 p.m. 1. Further Discussion on "Pneumatic Despatch Tubes." 2. "On the Stresses of Rigid Arches and other Curved Structures." By Mr. William Bell, M. Inst. C.E.

THE "ENGINEERING" DIRECTORY is published this week on the fifteenth page of our advertisement sheet.

NOTICE TO AMERICAN SUBSCRIBERS.

In consequence of the great increase in our American connexion, we have found it necessary to establish a branch office in the United States. Communications may in future be addressed to MR. GEORGE EDWARD HARDING, C.E., *of 176, Broadway, New York, who is our accredited representative.*

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of 1l. 14s. 8d. ($8.32, gold) per annum, payable in advance.*

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ENGINEERING.

FRIDAY, NOVEMBER 24, 1871.

THE MEGÆRA.

THE verdict of complete acquittal, given on Friday last, by the naval court-martial ordered for the trial of Captain Thrupp and the officers and crew of the Megæra, was one which must be thoroughly in accordance with the conclusions arrived at by all who have followed the evidence brought to bear upon the case. Indeed, as far as the public generally are concerned, Captain Thrupp and his fellow officers cannot have been said to have been upon their trial at all. On the publication of the despatches describing the state of the Megæra, and the circumstances under which she was abandoned, the conclusion was almost universally arrived at that those on board the vessel were in no way to blame for her loss; but that the calamity was to be attributed to administrative incapacity and negligence in a public department which has of late been earning a most unenviable notoriety. That this generally formed opinion was correct has been thoroughly substantiated by the evidence adduced before the court-martial. No one, however disposed he might be to smooth matters over, could assert with any show of reason that the loss of the Megæra was occasioned by an accident. The loss was beyond all doubt the result of either careless or wilful negligence on the part of those who sent the ship to sea, or on the part of those on board at the time of her abandonment. Those on board have been acquitted of the clearest possible evidence of all blame, and this acquittal can be regarded as nothing else but morally equivalent to a verdict of guilty against the Admiralty authorities.

It cannot be too clearly borne in mind that although the leak discovered was the cause of the Megæra being taken to the island of St. Paul's, yet that the leak alone was by no means the cause of her abandonment. The true cause was the disgraceful state of the bottom of the vessel, a state which showed that the leak which had broken out was but the forerunner of others—some probably of a more serious character—likely to be developed before the lapse of many days, and which was, in fact, such that Captain Thrupp would have been in no way justified in trusting the lives of his crew in the ship for the voyage to the nearest available port, a distance of 1800 miles.

It may be desirable that we should state here—even at the risk of recapitulating many matters with which some of our readers are familiar—the chief facts of the case, as proved by the evidence adduced at the inquest. In the first place, then, the leak—the position of which was discovered on the 13th of June—was situated abreast the mainmast, and on the port side, at a distance of 7 ft. 4 in. from the keel. It appears that in the Megæra the step of the mainmast was in the after part of the stoke-hold, and that a portion of a coal bunker came between the stoke-hold and the engine-room, which was, of course, further aft. It was under this coal bunker that the leak was situated, and it appears from the evidence of the chief engineer, that just at this point the frames were crossed by a strengthening plate, against which the water, entering by the leak, struck. Between this plate and the bottom of the coal bunkers there was a space of nearly 2 ft. To get at the leak for the purpose of repairing it, the web of a girder had to be cut through, and a sheet of india-rubber, ¾ in. thick, backed by a ¼ in. iron plate, was placed over the leak, and secured in position by a straight brace introduced between the patch and the strengthening plate already alluded to. The leak, when discovered, was found to be a hole about 2 in. long by 1 in. or 1¼ in. wide, the edges being quite sharp, and the surrounding plates so thin that the patch just mentioned had to be secured by screwing up the brace by hand only, it not being deemed safe to apply a greater pressure.

Subsequently on June 18th when the vessel was under the lee of St. Paul's, an outside patch consisting of a piece of bunker plate coated with prepared felt, was applied by the diver, this patch being secured by a ¾ in. bolt passed through it and an inside patch. The outside patch first applied got off again, however; but Mr. Mills states that a second piece was got on and made fast. Neither the inside nor the outside patches appear to have had any appreciable effect in stopping the leak, a result probably due to the crippled state of the plates in the neighbourhood of the hole; in fact the diver stated in his evidence that when "they were screwing the plate on from the inside I thought from the bend of the ship's plating from my place on the outside of the ship that they would have screwed the plate at the leak out altogether."

The pumping power available consisted of a 12 in. Downton's pump on the top deck, two 7 in. pumps on the main deck, one 7 in. pump on the baggage deck or cockpit, a 6 in. steam donkey pump with two plungers, two bilge pumps on the engine, and the bilge injection. According to the evidence of Mr. Bannister, the assistant engineer of Portsmouth Dockyard, the throwing power of these various pumps when working at 40 revolutions, or double strokes, per minute was as follows: 12 in. Downton 40 tons per hour, three 7 in. Downtons, 36 tons; donkey pumps, 21 tons; bilge pumps, 30 tons; bilge injection 300 tons. Mr. Bannister also included a hand pump capable of throwing 12 tons per hour, but it was shown afterwards that this pump was available for boiler feeding only, while the engineer of the Megæra affirmed that the bilge pumps being single-acting could deliver but 17 tons per hour. Up to the 15th of June it appears that the leak was kept under by using two of the 7 in. Downton pumps, assisted occasionally by the third; but after the last-mentioned date the bilge pumps had to be used, and also occasionally the steam donkey pump the latter being required when the suction of the bilge pumps choked and had to be cleared. The 12-in. Downton pump, was not used as it drew air with the small depth of water which it was desired to maintain in order to enable the men to cut away the girder to get at the leak. The bilge injection was unavailable for the same reason; but it is further asserted by Captain Thrupp in his statement in defence read to the court that: "the injection it was proved, could not be used rolling as the ship was, *without allowing the water to rise to such a height as to endanger extinguishing the fires.*" If this statement correctly represents the state of the case it would be desirable to know of what use a bilge injection so fitted was likely to be in practice, and under whose instruction it was so fitted. No evidence was, however, offered on this point.

It is impossible to state with any degree of accuracy what was the amount of water leaking into the Megæra at the time she was run on shore; but judging from the evidence regarding the pumping power used and its effects, we believe the quantity may be roughly estimated at between 40 and 50 tons per hour. If we take this latter quantity, and assume the lift to be that stated as the maximum by Mr. Bannister, namely, 24 ft., the work to be done in removing this water would be $50 \times 2240 \times 24 = 2{,}688{,}000$ foot-pounds per hour, or, say, 81 net effective horse power. If now, the Megæra had been fitted with engines having surface condensers provided with centrifugal circulating pumps driven by an independent engine, according to the system now largely adopted by some of the northern engine builders, the above quantity of water might probably have been removed (notwithstanding the friction caused by bends, suction roses, &c.) by the exertion of something like 160 indicated horse power. Taking into consideration the large surfaces for loss of heat by radiation, and the fact that circulating engines when made to develop such a power as that we have just stated, could not be supposed to work very economically, the consumption of coal under such circumstances may be estimated at about 5 lb. per indicated horse power per hour, or, say, 7 cwt. per hour for the 160 indicated horse power. Now the coal on board the Megæra at the time she was beached was 135 tons, and, with a consumption of 7 cwt. per hour, there would thus, under the circumstances we have supposed, have been enough fuel for 380 hours' pumping. Even under such circumstances, therefore, the quantity of coal on board would have been little more than sufficient to enable the pumping by steam at the rate of 50 tons of water per hour to be kept up until the Megæra had run the 1800 miles to the nearest port. But as it was the Megæra had no such independent circulating pumps, and the cylinder covers of her engines being cracked, it was not deemed safe to run them for pumping alone without the screw in use. To drive the engines at such a speed as to prevent the overrunning of the screw when the vessel was sailing at the rate of 8 or 9 knots, a consumption of 24 tons of coal per day was stated by Captain Thrupp to be necessary. The engines could thus have been employed for pumping for but about five days only, and probably of the whole indicated power developed not 20 per cent. would have been available for pumping purposes. We have so far neglected the pumps worked by hand, because their power was certainly not greater than it would have been desirable to have had in reserve in case of an increase of the leak; but it will be seen from what we have stated that had Captain Thrupp decided to sail from St. Paul's for the nearest port, he would before reaching the end of the voyage have had to depend upon hand-worked pumps alone, and that even had the Megæra being supplied with independent pumping engines, he would not have been able to pump out by steam during the remainder of the voyage a materially greater quantity of water than was leaking into the vessel at the time St. Paul's was reached. Captain Thrupp stated in his defence that it was not a deficiency of pumping power which induced him to abandon the ship; but we consider that even if he had not had other and still stronger reasons for that abandonment, the pumping power which was capable of being maintained was not sufficient to have justified him in continuing the voyage under the circumstances.

We have said that there were stronger reasons for abandoning the Megæra than the want of available pumping power, and we must now speak briefly of these reasons. Three weeks ago (*vide* page 271 of our number for October 27) we reprinted some extracts from the report of the diver as to the disgraceful state in which he found the bottom of the ship in the neighbourhood of the leak, when he examined it on the arrival of the vessel at St. Paul's. In giving evidence before the court-martial, the witness fully corroborated his former

statements. Thus, after describing the leak, he said:

The next worst place on the outside of the ship was about 4½ ft. before the leak, and, I think, the next line of plates above it. The corners of two plates where their butts met, and the lower edges, the two corners were either rusted or knocked away to the extent of 4 in. along the plate, and 1½ in. up the ends. The under corners, where the leak was, were gone completely for ½ in., and the seam where the two plates should meet was open, so that I could get the point of my knife into it with the greatest ease. I took my knife out of my belt and tried it, nothing resisting the knife. From the keel, commencing within 1 ft. after of the leak, for five or six plates from the keel upwards, and 10 ft. forward from where I went down first, it looked very rusty. On the plates in line with the leak, and the one above, some of the patches looked the largest. About 4½ ft. before the leak, where I went down before the leak, I touched each rusty spot with my hand, and they seemed to be below the level of the plate. About 10 ft. aft of the leak there was a patch, which I have described as looking like a Maltese cross. It was out of my reach, but seemed to be about 5 in. by 12 in. The space I examined was about 6 ft. fore and aft on the port side, and from the water-line down to the keel.

As regards the condition of the plates on the inside, also, we have the evidence of the chief engineer, Mr. Mills, who made the following statement before the court:

Above the leak there were rust holes, but not so many as below the leak. I should think that for a distance of 3 ft. on each side of the leak I examined the plates inside the ship both by sight and touch, using a hand lamp lashed on to a piece of wood, and passed through the hole cut in the girder. There were eleven rust holes over this space, and three of them very bad places, the plate "giving" to the pressure of the hand. . . . Five of the frames of the ship in the vicinity of the leak were very much eaten away.

Ample evidence was also afforded to the effect that the pumps were frequently choked by lumps of oxide of iron evidently washed off bad places in the frames and plates, and it is altogether impossible to doubt that, in the neighbourhood of the leak at all events, the bottom of the Megæra was in a most disgraceful condition, and the vessel absolutely unseaworthy.

This being the case, the great point to be settled is, who was responsible for such a disgraceful state of things? In the course of the evidence given by Mr. Mills, the chief engineer, it was stated that in the neighbourhood of the leak—about 2 ft. from the central line of the keel, on the port side, and abreast the main mast—there was a hand pump with a copper suction pipe and rose-box, while it was further stated that between the two frames, where the leak broke out, the plates were cemented for a distance of but about 2 ft. from the centre line, the remainder being bare. Under these circumstances an attempt was made by Mr. Barnaby to account for the condition of the plates by supposing galvanic action to have been set up by the contact of the bilge water with the iron plates and copper rose-box, and voluminous written evidence was adduced to show that similar results had been caused by such action in the case of H.M.S. Supply, in 1867. Mr. Barnaby went on to say that since the date just mentioned, the use of copper rose-boxes had been ordered by the Admiralty to be discontinued, and he went so far as to attribute "ignorance and neglect" to the officers of the Megæra, on account of their having allowed such a rose-box to remain in use. Mr. Barnaby's attempt to defend the Admiralty, at the expense of the officers of the Megæra, however, broke down utterly. In the first place one of the witnesses on his own side—Mr. Bannister, the assistant engineer of Portsmouth Dockyard—stated that with the suction pipe and rose-box placed as in the Megæra, with the water merely washing over it, and constantly changing in form, no danger was to be expected from galvanic action; second, James Thompson, a leading fitter at Sheerness Dockyard, who fitted the rose-boxes in the Megæra, stated that the rose-box of the pump in question was not of copper at all, but of wrought iron; third, Alexander Brown, the leading stoker of the Megæra, gave evidence to the effect that this rose-box was not situated between the same two frames as the leak, but between two adjoining frames; and fourth, it was impossible to get over the fact that if the rose-box was of copper, and if its presence had caused corrosion, the chief blame undoubtedly rested upon the dockyard officials who fitted it, and upon the inspectors who passed it when the ship was supposed to have been examined. Moreover, Mr. Barnaby's own evidence afforded an ample explanation of the state of the plates of the Megæra without there being any necessity to attribute defects to galvanic action. We pass over his explanation of the causes which led to the Megæra being transferred from the list of troopships to that of store ships, and we will even allow that this change was not made in consequence of any structural defects. Mr. Barnaby asserted, however, that in January, 1865, when this change was made the Megæra commenced "a new life;" but this life apparently was a remarkably short one, for in July, 1866, we find the Chief Constructor recommending a supplementary estimate, and giving it as his opinion that "the ship should remain fit for service for eighteen months or two years longer when repaired." In the report of July, 1866, it is also stated, however, that "the plates between wind and water all round the vessel to about 20 ft. from the stem, from the wall down to the first lap, for about 8 ft. in breadth amidships, and a breadth of 5 ft. fore and aft, *are very thin*, and although the vessel, if repaired, may be used for troop service, we are of opinion that she *will shortly require to be doubled* in the parts named." These thin plates have, according to Mr. Barnaby's own evidence, "*never been doubled or wholly removed*," yet nearly *five years* after the above quoted report was made we find the Megæra sent out with troops on a six months' voyage. It is true that the vessel was surveyed in April, 1870, but after receiving the report the Admiralty authorities directed the officers who made it to "reconsider their estimate, and report whether it could not be reduced." Under the influence of this gentle hint, the estimate *was* reduced, and the repairs were made accordingly. Lastly we find that in August last year the Megæra returned to England from Malta, and was ordered to be paid off into the fourth class reserve. A telegram from Captain Luard to the Admiralty to the effect that the vessel was "ready for one year's service at any moment," saved her from the fate she evidently deserved, and some months afterwards she was ordered off on her last memorable voyage with a recklessness which would be almost sublime, if we could get rid of the idea that it was criminal.

With such collateral evidence available concerning the past history of the vessel, there can be no excuse for regarding the accounts of the condition of the Magæra given by those who examined the vessel at St. Paul's, as being at all highly coloured. The statements made by the chief engineer and diver may be accepted as simple facts, and they are facts for the occurrence of which the nation will undoubtedly demand a complete explanation. In fact, it is already announced that a Royal Commission has issued to the Right Hon. Lord Lawrence, the Right Hon. Abraham Brewster, late Lord Chancellor of Ireland; Admiral Sir Michael Seymour, G.C.B.; Sir Frederick Arrow, Deputy-Master of the Trinity House; Mr. Rothery, Registrar of the High Court of Admiralty; and Mr. Thomas Chapman, F.R.S., Chairman of the Committee for Lloyd's Register of British and Foreign Shipping, and a Vice-President of the Institution of Naval Architects, directing them "to inquire into and report upon the state and condition of Her Majesty's late ship Megæra when selected for her recent voyage to Australia; the circumstances under which she was despatched from this country; the extent and cause of the leak subsequently discovered in the ship, and of any other defects in the ship's hull at the time when she was beached at St. Paul's; also, as far as may be deemed expedient, the general official history of the ship previous to her said voyage, and her classification at successive dates." We have in the present article merely touched upon the salient points proved by the evidence before the court-martial, but there are numerous other points upon which much might be written, and which go strongly to prove the incapacity which has of late distinguished our Admiralty administration. Inasmuch, however, as the matter is to be investigated by a Royal Commission, we prefer to reserve our further comments, and for the present we take our leave of the Megæra.

THE FISH TORPEDO.

At a time like the present when the torpedo is being so actively developed into a position which will unquestionably be a leading one in the naval warfare of the future, any new phase in the question becomes of equal interest and importance. Until very recently it was generally supposed that that question had been settled by the adoption of Captain Harvey's seamanlike otter torpedo for service afloat, and of the submerged electrical torpedoes designed by the Royal Engineers for stationary or coast service. We certainly shared this opinion in common with those who have for the past five years or so watched the gradual and satisfactory solution of the torpedo problem, and we were, therefore, not a little surprised to learn upon undoubted authority that our economical Government had given, or were about to give, 15,000*l.* for a very ingenious toy torpedo of Austrian extraction. The history of this torpedo presents many points of interest, especially at the present time, when the invention is to become national property at the expense of the national purse; and we may at once express our decided opinion that no results have been yet obtained with it to justify the action of the Government.

During the autumn of 1869 there might have been seen occasionally disporting itself in the waters at the little port of Fiume in the Adriatic, a self-propelled mechanical fish some 20 ft. in length, and of a form approximating to that of the swordfish. The idea of such a torpedo is due to one Captain Luppis, a retired officer of the Austrian navy, who proposed a moving and floating weapon, the fore part of which should be filled with explosive material and the after part devoted to the motive power which was originally intended to be steam. Such was the idea when it was communicated to Mr. Robert Whitehead, an English engineer resident at Fiume, where he held, and we believe still holds, the post of chief of an engineering establishment. Mr. Whitehead developed the surface torpedo into a submerged weapon, the propelling power of which was compressed air. He retained the form of the swordfish, but besides a projecting snout he gave it a vertical and two lateral projections—triggers in fact—by which the machine was exploded on contact. The snout acting also as a trigger, the weapon thus had four chances of exploding on hitting its mark. It is charged with any available powerful explosive compound, and can be propelled at any required depth below the surface of the water at a maximum speed of 12 knots an hour.

The head and shoulders of the fish now contain the charge, the body forming the engine room and storehouse for the compressed air, which works an internal engine, by which an external four-bladed screw is actuated. It is fitted with fins for the purpose of guiding it through a tube attached to a torpedo ship from which it is discharged into the sea for action. You have only—says the inventor in effect—to point the creature at its game, to cock its fins at the right angle, and to give it a pinch and a push when off it will go with undeviating accuracy to the mark. Nay more, it can be made to travel in any direction; to move at an upward or a downward angle; in horizontal plane; or to gyrate around a central point. Encouraged by such sanguine assurances, the Government purchased several of these torpedoes, and with them experiments were carried out in October of last year, to which we shall next direct attention.

The construction of these torpedoes was carried out at Chatham by the inventor with the utmost secrecy, and the most profound mystery was made to surround them. Our acquaintance with the weapon at the port of Fiume affords us a general knowledge of its construction, whilst for the rest we may observe that its details are of no great moment save to those who have sold and those who have bought the torpedo. In the Sheerness experiments the Oberon was used as a torpedo vessel, having been fitted with a tube 2 ft. in diameter and 28 ft. in length, placed in a line with her keel and some distance below her draught line. This tube was closed externally by a cap and was divided internally into two portions, each being rendered water-tight by means of penstocks, which also prevented the admission of water into the ship. The torpedo was passed into the rear portion of the tube upon rollers, and the penstock behind it being secured, the one in front was opened. The cap was then removed from the orifice and the weapon expelled from the tube by a piston arrangement. The fins act as guides bearing against four rails placed at the top and bottom of the tube. As the torpedo passed out of the tube a projecting lever caught against a stud in the latter and started the propelling machinery. Direction was given to the weapon by the course of the vessel, aim being taken by the steersman. On the occasion of the trials the hulk of the Aigle, which had long been used as a coal depôt in Sheerness harbour, formed the object of attack. The bulk was about 120 ft. long with 30 ft. beam, and was moored fast stem and stern. The Oberon steamed head-on to the broadside of

the Aigle until she nearly reached her, then she backed astern to a range of about 120 or 130 yards from the target. At a given signal the torpedo was liberated, and in about 25 seconds more it exploded against the hulk. The timbers of the Aigle were tolerably rotten so that 67 lb. of gun-cotton easily put an end to her existence. A smaller torpedo was subsequently discharged from a gig 20 ft. long against a netting target in which it was caught and exploded. The range was the same as in the previous experiment, and the object was to show that a vessel could be protected by such a surrounding, placed about 5 yards from her hull. This was supposed to have been demonstrated by the fact that the hulk behind the netting was not injured. The charge, however, was only 15 lb. of gly-oxalin, which is much smaller than would ever be used in practice. But what vessel on earth—we mean on water—would ever sail about with a crinoline of rope netting on?

Such are all the experiments, as far as we know, that have been made with this fancy weapon. Let us then see what they teach, and how far they justify a payment of 15,000*l.* for the secret of the invention alone, not to mention the cost of the torpedoes, which is very great. All that we at present know is, that to use these weapons, the torpedo vessel must approach within very close range of the enemy, and must then back and fill, and be brought to a dead stand, before delivering her charge. Aim must, moreover, be taken at an enemy's broadside, and the chances of escape for the torpedo craft from the guns of her adversary, are small indeed. Besides, it was a very easy matter to steer the Oberon direct on to the broadside of the moored and unresisting hulk of the Aigle, and to plant a torpedo upon her at a distance of 130 yards in the calm waters of the Medway. But what about a rough sea, a moving vessel with spiteful guns on board of her? or what of a dark night with a bit of wind on? We contend that it would be utterly impossible to deliver a fish torpedo successfully under any of the above conditions, so that we are reduced to the necessity of admiring Mr. Whitehead's skill in devising this ingenious weapon. In 1869 a Commission from the United States, consisting of Admiral Radford, and two officers from the U.S. frigate Franklin, was sent to Fiume to investigate the nature and powers of the fish torpedo. But it does not appear that they were particularly smitten therewith, as they left the inventor in undisturbed possession of his secret. Austria, it is said, has paid a good round sum for the invention, but she does not seem to think very much of it, or to have utilised it, and such will doubtless be the result of our experience in the matter.

SANITARY IMPROVEMENTS OF PARIS.

M. Belgrand, Inspector-General des Ponts et Chaussées, and director of water and sewage, has just published a pamphlet on the sewage system of Paris, and on modifications of the present system of outfall and the utilisation of the sewage. These important matters, although they have been largely and for a long while discussed, have advanced but little up to the present time, when the actual conditions give rise to the most energetic complaints. The chief inconveniences encountered are as follows: The houses with fixed cesspools deprived of water distribution are unhealthy; the raising and transport of sewage are costly, and fill the city with noxious odours; the deposit of these matters at Bondy renders the neighbourhood almost uninhabitable, and greatly depreciates the value of neighbouring property; the discharge of the sewers into the Seine encumbers the river, and sullies the water for a long distance beyond the point of outfall; and, lastly, a great mass of fertilising matter is lost to agriculture.

Our readers are familiar with the actual condition of the sewage system of Paris, and are acquainted with its various imperfections; they will remember also that experiments crowned with great success were carried on more than three years since in the plains of Gennevilliers, close to the outfall of the collecting sewer at Asnières, for the purification and the use in irrigation of the water from the sewer; and also that the dividing system, or that of the "*tinettes-filtres*," (which separates the solids from the liquids, preserves the first in vessels easy of removal, and conveys the second it may be into reservoirs, it may be into the sewers), is applied already to more than 18,000 closets out of about 236,000; this system shows already an important progress as compared to that of the fixed cesspools.

M. Belgrand was the constructor of the magnificent system of sewers in Paris, and it was he also who superintended the designs and the execution of the great works which supply Paris with water. But in spite of evidence which poured in on all sides concerning the numerous requirements for a real sanitary system, it was with difficulty he was brought to admit that, after having done so much, there still remained so much to do, and so the system of getting rid of the sewage was retained in all its barbarity; thus the "dung-heap of Bondy" was preserved, thus the Seine was still fouled with the outfall from the sewers, and the Gennevilliers experiments were disregarded.

M. Belgrand's ideas have, however, progressed, and, while wishing to preserve the right of maintaining the Bondy establishment, and of polluting the Seine, he admits that there are important reforms to be effected. The municipal administration of Paris does not acknowledge any absolute obligation, but it recognises the existing evils, and wishes to remove them.

The city of Paris possesses at present about 335 miles of sewers, and about 220 miles more will have to be made to secure a direct sewer communication with all the houses. The use of water in closets, against which the inhabitants now commonly protest, on account of the increased amount of their sewers rates, will be rendered obligatory, and will, of course, bring about a better state of cleanliness and health. A tax of 30 francs per closet will be levied for connecting the house with the sewer to carry off the liquid portions of the sewage; this tax will amount to 7,000,000 francs. The complete discharge of all the sewage would not be incommodious to the sewers of large section. The practice is already established as far as regards some public buildings, and by way of experiment it is to be tried on 2000 private houses. A tax of 53 francs per closet will be charged for this arrangement. The execution of 220 miles of sewers, which ought to precede the complete realisation of the project, will cost 1,600,000*l.*, and will occupy several years.

The irrigation of the plain of Gennevilliers having given good results will be developed and extended, at first to allow one-third of the total sewage discharge. A sum of 200,000*l.* would be required to execute the necessary works for bringing the sewage upon the lands, the 5000 acres of which will be more than sufficient for the absorption of the sewage.

A municipal council will probably be soon assembled to consider the propositions contained in M. Belgrand's report, and especially the following points:

1. The establishment of service drain-pipes with the sewers, and the substitution of the apparatus known as the "*tinettes-filtres*" for the cesspools and "*fosses mobiles*." The consequence of this first measure would be the suppression of the method of sewage discharge, and of the Bondy depôt, and the possibility of purifying the dwellings of workmen.

2. Experiments of complete discharge into the sewers, that is to say, the substitution of simple service pipes, for the cesspool and "*fosses mobiles*," conducting to the sewers the whole of the solid and liquid matters, and of course doing away with the cost of the "*tinettes-filtres*," and that of emptying the solid matters which they contain.

3. The establishment of a tax of 30 francs for each closet that discharges into a *tinette-filtre*, and 50 francs for each complete discharge into the sewers.

4. The application of the tax to the completion of the network of sewers, and developing the employment of the sewage water to the profit of agriculture.

From the foregoing facts we may gather that the sanitary condition of Paris is in a good way to be improved, and if the Municipal Council regard the matter in a proper light, there will be no time lost in contracting the necessary works, and it is probable that the successful utilisation of sewage on a grand scale may become an accomplished fact in the environs of Paris, before either the Metropolis Sewage and Essex Reclamation Co., or the A. B. C. combination have effected much.

Telegraphs in Turkey.—The Turkish postal and telegraph service has been amalgamated under Achmet Bey (brother of the Grand Vizier) and an administrative council. The general direction of the combined offices has been transferred to the telegraph office in Stamboul.

THE ENGLISH AND PRUSSIAN FIELD GUNS.

Towards the close of last week, and during a part of this, a series of competitive trials has been carried out at Shoeburyness between the English and Prussian 9-pounder field guns. It will be remembered that these guns have been previously experimented with, and were to undergo further trials, at increasing ranges and high angles. The Prussian gun is known in Prussia as a 4-pounder, that being the weight of the round shot it carries, but as it fires a 9.5 lb. cylindrical shell, it is really to be taken as a gun of the latter capacity. It is a breech-loading rifled gun, the English 9-pounder being a muzzle-loader. The practice has been made against four rows of targets, each having a frontage of 54 ft. wide by 9 ft. high, the rows being placed 60 ft. apart, one beyond the other, giving a depth from front to rear of 180 ft. The first series of experiments was carried out at the very high range of 2500 yards. Ten rounds were first fired from the Prussian gun with charges of 1 lb. 1.6 oz. of R.L.G. powder, and Prussian common shell, fuzed with Prussian percussion fuzes—elevation 5 inches. All the ten rounds were effective, and the shell broke up admirably. An examination of the targets showed 56 thorough penetrations, 31 lodges, and 57 strikes, giving a total of 144 hits. The English gun then fired ten rounds with 1 lb. 12 oz. of R.L.G. powder, and common shell, with Royal Laboratory percussion fuzes—elevation 6 degrees. All the rounds were effective, the results being 59 throughs, 21 lodges, and 27 strikes, giving a total of 107 hits. Ten rounds were then fired from the same gun with shrapnell shells, with Royal Laboratory percussion fuzes, at an elevation of 6 to 6.48 degrees. Nine rounds out of the ten proved effective, giving, as a result, 39 throughs, 45 lodges, and 41 strikes, or 125 hits. The best practice in this series was made with the last ten rounds from the English gun, firing shrapnell shells, with wood time fuses, bored to 1.6, elevation 6 degrees 48 minutes. Eight rounds were effective, giving 202 throughs, 41 lodges, and 69 strikes, and consequently the large number of 312 hits.

In the more recent trials the Prussian 4-pounder (=9-pounder English) and the English 9 and 16-pounder guns competed. The Prussian gun was first fired with the same powder charges as before, and common shells with bursting charges of 6¼ oz., fuzed with Prussian percussion fuzes. The targets were similar to those in the previous practice, the range being increased to 3000 yards. Ten rounds from the Prussian gun with varying elevations reaching 11½ degrees, gave 4 throughs, 7 lodges, and 10 strikes, being a total of 21 hits. The second series was with the English 9-pounder, with the same powder charge as in the previous practice, and common shells with bursting charges of 8 oz., fuzed with percussion fuzes, elevations from 8 deg. 15 min. to 9 deg. The ten rounds gave 19 throughs, 12 lodges, and 7 strikes; total, 38 hits. The same gun firing ten rounds with shrapnell shells, with ¾ oz. bursting charges, and fuzed with percussion fuzes gave 3 throughs, 4 lodges, and 19 strikes, or 26 hits in all. Ten more rounds from the same gun firing shrapnell shells with ¾ oz. bursting charges, and fuzed with wood 9-seconds time fuzes gave 69 throughs, 46 lodges, and 43 strikes; total, 158 hits.

The next series was with the new English muzzle-loading 16-pounder rifled field gun, firing charges of 3 lb. R. L. G. powder and common shells, with bursting charges of 1 lb., and fuzed with percussion fuzes. The results on the targets were 49 throughs, 7 lodges, and 16 strikes; total, 72 hits. The same gun then fired ten rounds with shrapnell shells, with 1¼ oz. bursting charges, and fuzed with percussion fuzes. The results here were 111 throughs, 37 lodges, and 19 strikes, being a total of 167 hits. The seventh and last series in these trials, so far, was with the same gun firing shrapnell shells, with bursting charges of 1¼ oz., and fuzed with wood 9-seconds time fuzes. This time the targets showed 212 throughs, 118 lodges, and 90 strikes, giving a total of 420 hits.

Undoubtedly both the English and the Prussian 9-pounder guns are very fine weapons, but whatever advantages breechloaders may present in some respects, those most prejudiced in their favour cannot ignore the power and excellence of the shooting of our new muzzle-loading 9-pounder guns. The difficulties of shooting effectively at such long ranges with the guns and targets on the same plane, as they were throughout the practice, will be under-

stood by those who are practically acquainted with gunnery, and the value of the results obtained will be realised. The comparison of the practice of the English 9-pounder with that made by the Prussian 9-pounder, however, is very notable in the later experiments. It will be seen that the total number of hits made with the Prussian gun firing common shells was 21. The English 9-pounder made 38 hits with the same kind of shell, whilst with shrapnell shells having time fuzes, no fewer than 158 hits were made. These results point to the superiority of the English system of bursting shells by time during flight.

Turning to the new 16-pounder gun, we find it maintaining the good position it won in previous experiments. The results of the targets show that with common shell it made 72 hits, whilst with shrapnell shell and time fuzes these results were increased to 420 hits, out of which 212 were thorough penetrations. It would seem that the Prussian gun had reached its maximum range at 3000 yards, as the curve of its trajectory was very high. The trajectory of the English 9-pounder, however, was much flatter, a circumstance greatly in its favour, and which is probably due to the larger powder charge it burns. The experimental practice, which proves very satisfactory, was carried out under the directions of the committee appointed to investigate the results of high-angle and vertical fire from rifled howitzers and mortars, and on muzzle-loading rifled field guns. It is known as the High-Angle Firing Committee, General Eardley-Wilmot, R.A., being the president, and Captain Llwellyn, R.A., the secretary.

PATENT FUEL.

"Take three parts of the best New-castle coal beaten small, one part of loame, mix these well together into a masse with water, make thereof balls, which you must dry very well. This fire is durable, sweet, not offensive by reason of the smoke or cinder as other coal fires are, beautiful in shape, and not so costly as other fire, burns as well in a chamber even as charcoal." The foregoing extract, taken from a fragment of an old book supposed to have been printed about the year 1670 or 1679, and headed "An excellent Invention to make a Fire," contains probably the earliest reference on record to the manufacture of what is now commonly known as artificial, or patent fuel. At that date, however, very different reasons existed for preferring such a fuel to coal in its natural state, to those which now prevail, as an inducement to its manufacture. When coal was first introduced into London, the greatest possible objections were raised against it, and the manufacture of the compound fuel above described is evidence of the strong prejudice then entertained to the use of coal. In the life of Mr. Locke, we are told (1679) that the Earl of Shaftesbury required Mr. Locke to return to London. "He accordingly returned thither, but not being wholly recovered, and finding himself afflicted with the asthma, he could not tarry long at London, the sea coal that is burnt there being so very offensive to him." Poor Mr. Locke! But it may reasonably be asked, what would be his feelings now, could he pay a visit to his former haunts in London upon a foggy November day? Fortunately we inhabitants of this great metropolis, in the nineteenth century, have become so far acclimatised, as to be not only above complaining of such trifles as coal smoke, but most of us even wish that the fuel could be obtained more cheaply, so that we might burn more of it. The question then, at the present day, which concerns the manufacture of patent fuel, is not one of prejudice, but of necessity; for the waste of our coal resources has at last assumed such gigantic proportions as to have attracted the attention of the Legislature, and no one studying the interesting reports of the late Coal Commission can fail to be struck with the enormous national loss which is now annually endured owing to the want of some efficient means for the economical utilisation of the small coal which is now unavoidably made even under the very best known systems of coal working. Probably it would not be in excess of the fact to assert, that fully one-third of the coal now hewn is reduced that state wherein it becomes known as "small," "slack," or "duff," and not more than two-thirds becomes ultimately burnt in the shape of "round" coal. The small produced in bituminous coal seams will coke well, and it is much used for that purpose; but the demand for coke not being in any way equal to the supply of bituminous small coal from which it might be made, a great proportion of the latter is left underground, and ultimately becomes lost beyond all possibility of future recovery. The small from steam coal will not coke; and hence it is, as a rule, almost invariably left below, as it would not pay to raise it to the surface so long as there is no market for it, and it could only be thrown on one side in a heap, occupying ground which might be better and more conveniently used for other purposes. With the extended manufacture of patent fuel—which at present appears to offer the only means of profitably utilising small coal to any great extent—not only would a market be provided for small coal which now unavoidably collects at the pit's mouth, but if carried on upon a sufficiently extensive scale, it would afford sufficient inducements to the colliery proprietor to bring up all the small coal that could be raised, together with the round coal. At present this manufacture may be said to be quite in its infancy, and it employs only a very minute proportion of the small unavoidably made at a comparatively few collieries, and its results in this respect are wholly unappreciable excepting at a few pits in the immediate vicinity of the manufacture. Thus there is room, as there is also an urgent necessity, for the establishment of works of this nature throughout the length and breadth of the kingdom wherever coal is to be found; moreover, it is quite possible that patent fuel may, from its utilisation of small coal, render it possible at some future time, to work seams with profit, which either from their softness and friability, or for other reasons, are now looked upon as worthless.

The first patent taken out for the manufacture of patent fuel was in December, 1799, by one John Frederick Chabannes, but it is probable that the process described above as having been adopted 120 years previously, had in the meantime undergone some improvement. According to this invention small coal was to be consolidated by mixing it with "earth, clay, cow-dung, tar, pitch, broken glass, sulphur, sawdust, oil-cakes, tan, or wood, or any other combustible ingredient, to be mixed together and ground with a wheel in water in a wooden vessel; the mixture is then to be placed in pits provided with drains for the water to run off, and when dry is to be moulded into cakes." Impracticable as the process above described must have been, it no doubt served as a basis upon which many similar patents have been subsequently drawn up. The next invention, dated 20th May, 1800, was for putting small coal, together with certain other ingredients, into an oven or kilns, causing the several particles to unite together by fusion; a system which, upon experiment, must have been found to be utterly impracticable. The first really practicable system suggested for the manufacture of patent fuel was one patented by Peter Davey, in 1821, which is the first time that any proposal appears to have been made to form the mixture into blocks by pressing it into moulds. Between that time and now—that is to say, during the last 50 years—the question of patent fuel manufacture has been steadily growing year by year into greater importance, and many are the names of those who have given their attention to the matter. If the mere fact of taking out patents had been sufficient to induce the manufacture of any article in proportionate quantities, we should not now have to complain of the millions of tons of small coal which are being annually wasted. For one reason or another, this manufacture has not kept pace with the requirements of the times owing probably to this fact, as much as to anything else, that the various patentees in this field of enterprise, know very little about the real merits of the question, desiring rather to see others carry their suggestions into practice than to risk any money upon them themselves. The few patent fuel manufactories that now exist, are upon a small scale only, and are little better than private enterprises, although some of them rejoice in the title of "company." What is really wanted is a company in which a sufficiency of capital for the carrying out of the manufacture on a large scale, is combined with a practical knowledge of the subject by all to whom its interests are confided. As a proof of the total want of the last-named qualification in certain instances, it may be mentioned, that among the most common errors of would-be fuel manufacturers, is the one that by mere mechanical combination of materials, results may be obtained equivalent to a chemical change in the ingredients themselves; thus, that by the mixture of anthracite and bituminous coals a fuel may be obtained corresponding in its properties to steam, or semi-bituminous, coal; or, that by mixing a very good and a very poor coal together a fuel of a fair average quality may be obtained. Nothing could be further from the truth, for by no means can mere mechanical combination alter the nature of the several ingredients used. In a fuel thus made with a mixture of coals each particle will burn in the precise manner, and give the results due to the peculiar seam from which it was taken; whilst the pitch, tar, or other medium used for combining the small particles together will, in like manner, give out the flame, heat, or smoke due to its combustion under similar circumstances when not forming part of a block of artificial fuel.

Owing to the convenience of stowage, and that patent fuel occupies much less space per ton than coal in its natural state, the former is chiefly in demand for shipping purposes, and the small coal used is almost exclusively that from the steam collieries. The principal seat of its manufacture is in South Wales, whence steam coal is shipped chiefly for foreign ports; but there is no apparent reason why this manufacture should be so confined to one spot, when it would be equally beneficial in the vicinity of all our coalfields throughout the United Kingdom. For whatever purpose coal from any colliery is used, patent fuel made from the dust of such coal should find a ready market, with this reservation only, that it must be borne in mind that a process of manufacture suitable for steam purposes will not always be applicable to fuel for domestic use, but the converse will not equally hold good, for any process that will produce the latter kind of fuel should be equally good if applied to steam coal. In most of the patent fuel manufactures for shipment for steam purposes an excess of bituminous matter is introduced, either as pitch or tar, which not only would be objectionable to the senses, if used for domestic purposes, but it would require a greater draught in order to secure proper combustion, and consequent freedom from smoke than is usually obtained in domestic fireplaces.

THE SEWAGE AT BIRMINGHAM.

(*Continued from page 315.*)

Having thus examined and rejected the various processes for purifying sewage by precipitation and artificial filtration, the Sewage Committee pass to the consideration of the only remaining mode of purifying sewage, viz., passing it through the natural soil. This mode of dealing with sewage divides itself into two different systems of irrigation. We have the system of irrigation aiming at utilisation no less than purification; and irrigation which aims only at purification, to the neglect of the manurial value of the sewage. The first is as much an agricultural as a sanitary question. The second is primarily a sanitary problem, being, in fact, merely a process of natural filtration, initiated and controlled by artificial drainage works. In examining the problem of utilisation the committee endeavoured to obtain such information as should answer the following questions:

"1. Does ordinary sewage possess a manurial value sufficient to induce landlords or tenants to incur the expense, which is considerable, of laying out land for its reception by way of irrigation?

"2. Can it be applied continuously without injury to the permanent fertility of soil?

"3. What area of land of a given character is necessary for the perfect utilisation of sewage of given quantity and strength, so that no fertilising element of the sewage shall be wasted?"

In order to satisfy themselves upon these points the committee visited the sewage farms at Warwick, Rugby, and Romford, and also addressed a paper containing forty-four questions to the various towns which have already adopted the irrigation system. The Table we quoted on page 274 gives the chief facts elucidated by these questions. From the personal inspections made by the committee at Warwick, Rugby, and Romford, the following information has been gleaned.

Warwick.—The population is 11,000. The number of water-closets being 2400, Warwick offers a complete example of a water-closet town.

The dry weather flow of sewage is 528,000 gallons per day. This is pumped to a height of 65 ft., and conveyed to a farm of 135 acres of clay soil, lying about 1¼ miles from the town. Hence

we have the sewage of eighty-five persons to each acre; but the borough surveyor of Warwick is of opinion that each acre of such land can only utilise properly the sewage of fifty persons. The cost of conveying the sewage to the land, including pumping engines, has amounted to 10,085*l.* The land has cost from 1*l.* to 10*l.* per acre for laying out. The annual cost of pumping, not including interest on capital, is 600*l.* The rent of the farm is 420*l.* 10s., and the total annual cost, including interest on capital, coals, expenses of pumping, rent, and all ordinary expenses on the farm, is stated to be 1000*l.* A great defect on this farm is that the sewage runs over, rather than through the soil, by reason of the land being undrained. Drainage is, however, now being carried out to an average depth of 3 ft.

Rye-grass is grown on about 60 acres. This crop is irrigated once a week from five to eight hours at a time, and cut five or six times during the year. Cabbages, mangolds, potatoes, and other green crops are also grown, and a small quantity of oats and wheat. The wheat is not irrigated at all, and the oats only two or three times during the season.

At present the sewage is used in the raw state, but it is intended to adopt some means of separating the suspended solid matters before using the sewage for irrigation. In the case of fallow land such separation is not necessary. A garden attached to the farmhouse is irrigated with the sewage, and produces luxuriant crops of cauliflowers, cabbages, asparagus, parsnips, vegetable-marrows, onions, leeks, kidney beans, beet, strawberries, tomatoes, and watercresses.

The experience with this garden is very important, inasmuch as it shows what valuable results might be obtained by the formation of large market gardens as part of future sewage farms. It is satisfactory to note that the farmers in the district, who were much opposed to the idea of sewage irrigation when the farm was first laid out, would now be glad to get sewage for their own land. The financial result seems to be by no means unfavourable. The total outlay, as above given, being 1900*l.*, and the estimated value of the crops 2071*l.*, a profit of 171*l.* remains. This could, no doubt, be more than proportionally increased if the size of the farm were doubled, so as to use the sewage of about forty persons per acre.

Rugby.—About 8000 people here contribute to the sewage. The dry weather flow is about 202,000 gallons daily. The sewage farm at Rugby is only 65 acres in extent; the rental is 4*l.* an acre.

On this farm the sewage of one hundred and twenty-three persons is put upon each acre of land. This land has been cropped during the present year in the following way: Oats, 8 acres; wheat 13; mangolds, turnips, and carrots, six; and the remaining 38 acres with rye-grass. This farm only deserves notice as an example of what a sewage farm *should not be*. There was a very offensive smell caused, and the effluent water was not at all satisfactory.

Romford.—Out of a total population of 8000, 7000 contribute to the sewage. The dry weather flow is about 247,000 gallons daily. Some portion of the storm and surface water is discharged direct into the river Rom, but the greater part goes into the sewers.

The area of the sewage farm is 121 acres, therefore the sewage of fifty-eight persons is applied to each acre. To command the farm it is necessary to pump the sewage to a height of 25 ft. This farm is furnished with pumping engines, tanks, and iron troughs, which cost the Board of Health 4300*l.* After the purchase of the farm by the Local Board it was let to Mr. W. Hope, on a seven years' lease. By the terms of this lease the Board of Health pays the cost of pumping, which amounts to about 150*l.* per annum. Mr. Hope pays a rental of 2*l.* 10s. per acre for the land, and 600*l.*, or 5*l.* per acre, for the sewage; holding himself responsible for the thorough purification of the sewage, and guaranteeing the Board against any actions for nuisance. Mr. Hope has himself laid out the farm in the following way: All the hedges, ditches, banks, and trees were cleared away, and a complete system of concrete carriers constructed, for distributing the sewage to all parts of the farm.

"The ridge and furrow system of distributing the sewage is employed as follows:—The land is laid out in long beds 30 ft. wide, at right angles to, and sloping from, the carriers. Along the central line or summit of each bed, from which the surface falls gradually 15 ft. on each side, is a narrow gutter or grip, into which the sewage is discharged by taps of a simple construction in the iron troughs and by sluices in the concrete carriers, and a workman walks down the bed with a spade or iron plate in his hand, with which he stops the flow of sewage at intervals, so that it then flows over the surface of the bed on each side of the grip.

"The mud deposited in the tank is usually removed each day, and put upon the poorest portions of the land.

"The farm, both in its character and position, is very favourable for sewage irrigation. The soil is very poor, light, and sandy, with a gravel subsoil, and requires a maximum amount of moisture, and its proximity to the London market enables Mr. Hope to farm it as a market garden, and thus, by a constant growth of rye-grass and green vegetables, to obtain the most favourable pecuniary results from sewage irrigation.

About 85 acres of land above the level of the tank are drained from 5 to 6 ft. in depth, at intervals of 50 yards, in such a manner that the water from the drains can be discharged again into the tank, if required, in dry weather, and so be pumped back again over the farm, or it may be discharged direct into the river."

Mr. Hope considers the quantity of land he has at present insufficient, and he is now in treaty for 80 acres of additional land adjoining the farm. On this land Mr. Hope intends to raise cereals. When this alteration is made, the proportion of sewage will be diminished to that of thirty-five persons per acre. This Mr. Hope thinks a maximum.

It is a noticeable fact that Mr. Hope irrigated a field of rye-grass and mangolds, adjoining his own farm, with such beneficial results that the tenant would now like to arrange for the use of sewage on his whole farm of 500 acres.

Mr. Hope has lately laid out a farm of 270 acres at Halsted, on the Colne, to use the sewage of six hundred persons. This is at the rate of twenty-two persons to the acre. This farm is to be cultivated in the ordinary way. That is to say, it will not be used in the manner customary with other sewage farms, but rather according to the routine of ordinary farming. Rye-grass, cabbages, swedes, and other roots will be grown on a part of the farm regularly irrigated. These crops will be then used for feeding stock, and the manure produced by the animals so fed will be used on the remainder of the farm for the growth of cereals.

(*To be continued.*)

THE 35-TON GUN.

YESTERDAY afternoon some further trials of the 35-ton 700-pounder gun took place at the proof butts, Royal Arsenal, Woolwich. The object was to test the new iron carriage upon which the gun has recently been mounted, and more especially the bearings in which the trunnions work, which are of Vickers's homogeneous mild steel. Velocities and pressures were also taken by Captain Noble. Four rounds were fired with satisfactory results, the greatest recoil being 7 ft. 6 in., the iron framing of the carriage running up iron-plated slides set at an angle of 8 degrees. One or two more rounds will probably be fired from the gun to-day, after which it is to be sent to Shoeburyness for its range, accuracy, and penetration trials. We are glad to find that the authorities have abandoned the idea of enlarging the bore of the gun beyond the present calibre of 12 in. Pressure on our space obliges us to defer the details of yesterday's practice until next week. It was very satisfactory as regards the carriage, although some anomalies presented themselves in the powder pressures, two charges of 120 lb. of pebble powder giving 21 tons and 40 tons respectively at the breech of the gun. Both gun and carriage are intended for the turret of the Devastation.

THE AUTOGRAPH OF HENRY BELL.—Mr. B. Woodcroft, of the Patent Office, 25, Southampton-buildings, London, W.C., is anxious to obtain a copy of the autograph of Henry Bell, engineer of the Comet steamboat, which ran on the Clyde in 1812. He would esteem it a favour if any of our subscribers would kindly inform him, either directly or through the medium of our pages, where such autograph is to be found.

PUBLIC WORKS IN PARAGUAY.—Messrs. Robinson and Fleming announce that they are authorised by the Consul-General in London of the Republic of Paraguay, special commissioner for the loan, to receive subscriptions for an Eight per Cent. Public Works Loan of the Republic of Paraguay under Acts of Legislature of the Republic of the 6th of December, 1870, and of the 17th of May, 1871, to the amount of 1,000,000*l.* stock, in bonds of 1000*l.*, 500*l.*, and 100*l.* each, bearing an interest of 8 per cent. per annum payable quarterly, from the 15th of September, 1871. The price of issue is 80 per cent. The quotation is 2 to 2½ per cent. premium.

THE THROUGH RAILWAY ROUTE TO INDIA.

A PAPER of much interest was read before the Society of Arts, on Wednesday night, by Dr. Hyde Clarke, in which he dealt with the progress that has recently been made in perfecting a through railway communication with India. Without following slavishly the route of any particular projector, he advocated that which is the shortest and most free from engineering difficulties, and which will place us in direct communication with our Indian Empire at the least possible cost. To avail ourselves of the existing lines to Vienna, and of those to be soon completed to Constantinople, thence to Bagdad and Bussorah, along the north of the Persian Gulf to Bushire, thence by the coast of Balvelistan, and join the Indian system at Baroda. As a long resident and Cotton Commissioner in Turkey, it struck him that most of the projectors of various routes had been neglectful in consulting the interests of Turkey, as a continuous line to India must pass through Turkey in Europe and Turkey in Asia, and this has been, in his opinion, one of the great causes which has retarded the progress of various undertakings, and has ended in some of the works being confided to foreigners instead of to Englishmen. Because we want to go to India, we set aside the consideration that the Turks want to connect Constantinople with the European system, and because we want to reach Bagdad, Bussorah, and Bombay, we forget that the Turks have their own need for communicating with the two former cities from their metropolis, and that they have political objects to accomplish and local acquirements of traffic to satisfy. The European system reached Basiash on the Danube some years since, and there it halted. The Sultan, instigated by what he had seen in his recent visit to England, granted concessions for the European and Asiatic sections; the former to connect the European or Austro-Hungarian lines and the Danube with Constantinople, comprising cross lines, one from Nish South to reach the Mediterranean at Salonica, another from Adrianople to the same sea for local purposes, and a line from Adrianople by the shore of the Black Sea to reach the Varna and Rustchuk Railway, the point of juncture with Austro-Hungarian lines being near Belgrade, the great nucleus of the main Roumelian artery being Adrianople, where the works have already began. On the eastern side they are in active progress towards the city of Filibeh; on the western the works are being carried to Dédé Aghij. With regard to the Asiatic or Anatolian section, the great financial difficulties attending its realisation have prevented the Turkish Government from energetically taking it up, and the same cause has prevented the present construction of a bridge over the Bosphorus, for which plans have been made by Mr. McClean and others. At the point of Ismid begins the great question of the course of the line to the East—one route by east to Persia, which has the disadvantages of passing through the unsettled countries beyond—though the difficulties of hostile regions have been much lessened by the experience gained by the great Pacific Railway passing through the territories of inimical tribes. On the subject of the various routes from Constantinople and the Black Sea to Bagdad and Persia, Sir H. Rawlinson has given most valuable information before the Parliamentary Committee. The caravan route is one. The great river Sakaria offers a natural valley, thence to the great table-land of the interior to Konieh, a route which has been carefully explained in the paper by Colonel O'Reilly. South of Konieh is one of the great difficulties of this part of the undertaking—the passage of the chain of Taurus by the Gulek Boghasi Pass—which is rendered more practicable by experience gained during the construction of the Mont Cenis line. We have now to reach the portion known as the Euphrates route, with the alternative of the Tigris route; the former designed by General Chesney, and advocated and schemed by Mr. W. P. Andrew. Either will reach Bagdad, and from thence to Bussorah. In India we have a connected railway system from Bombay, and there will be another port of junction at Kurrachee, which system is joined to Bussorah and Bagdad. Such undertakings bringing with them the blessings of prosperity, and increasing the guarantees for peace, will tend to promote the welfare of our people in India and of the natives under our protection and tutelage.

COAL IN RUSSIA.—Two of the southern and one of the western Russian railways will in future burn only coal. The wood of the Empire is being burnt up too rapidly by locomotives.

TITANIC STEEL.—We notice that Messrs. Samuel Osborn and Co., of the Clyde Steel and Iron Works, Sheffield, have arranged to continue the manufacture of "R. Mushet's special steel," and Mr. Mushet's other titanic steels hitherto made at the Titanic Steel and Iron Company's Works. We are glad to find that the manufacture of these steels is being taken up by a Sheffield house, for it is at once a testimony to the excellence of their quality and a recognition of the successful persistency with which Mr. Mushet has advocated the use of titanium in the production of high class iron and steel. The extraordinary strength and toughness of Mr. Musket's titanic steel as shown by Dr. Fairbairn's experiments, was the subject of remark in these columns at the time of those experiments being made public; and more recently we gave from personal observation some particulars of the remarkable properties of Mr. Mushet's new non-hardening special steel. Now that the manufacture of these steels has passed into the hands of Messrs. Samuel Osborn and Co., they will doubtless be still more extensively used. When speaking some time ago of the non-hardening special steel we directed attention to its endurance when used for tools in machines driven at higher speeds than usual, and, at the present time, when with the shorter hours of labour it has become more than ever an object with engineers to get as much work out of their lathes and planing machines as they can in the shortest space of time, this point is worthy of notice.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig Iron Market.—On Friday last the advance in the price of Scotch pig iron had proceeded so far that the quotations were, at one part of the day, 70s. 6d. cash and 70s. 9d. one month. Towards the close, however, there was a decline, and on Monday there was a marked degree of slackness, the prices being 69s. 6d. to 69s. cash, and 69s. 10d. to 69s. 4½d. one month, and sellers remaining at the lower figures. Yesterday's market was also flat, prices fluctuating between 69s. 3d. and 68s. 4½d. one month, and 68s. 9d. and 67s. 10½d. cash. The market has again been strong to-day, 68s. 3d. to 68s. 6d. cash, and 68s. 6d. to 68s. 10½d. one month being given. The quotations for No. 1 iron and certain special brands are as follows: Gartsherrie and Coltness 82s., Calder 80s., Glengarnock 18s., Shotts 77, Carron (New) 75, Chapelhall, Carnbroe, and Langloan, 75s. The demand for makers' iron is still very great, and indeed the orders cannot be overtaken. The American demands are very pressing but merchants are declining to charter vessels owing to the difficulty of getting iron from the makers. Last week's shipments of Scotch pig iron were: Foreign, 9886 tons; coastwise, 6934 tons; total, 16,820 tons; same week last year, 14,125 tons; increase, 2,695 tons; total increase since Christmas, 183,583 tons, as compared with the year 1869-70. It is stated that the best Gartsherrie brands have never been at such a high price since the year 1857. Certainly there is a most unusual degree of activity in the Scotch pig iron trade. The stocks in public stores are rapidly diminishing. In reference to the failure of a member of the "Iron Ring" mentioned in last week's "Notes," it may now be stated that it was that of Mr. Thomas Thorburn, whose liabilities were stated at 20,000*l*. A settlement has been made this week, the composition being 5s. 6d. per pound sterling.

Vacuum Sugar Pans.—A large number of sugar pans of the most approved description are now being constructed in Greenock by Messrs. James Duff and Sons and Messrs. Wm. Adam and Co., coppersmiths. The former firm have on hand five pans for local refineries and one for a Liverpool house. The latter firm have on hand two pans for a local refinery, and two for a Bristol house. They are of very large size, and of the newest design. The average cost of each pan is about 1500*l*.

New Railway Schemes.—The Scotch railway schemes that are being matured for the ensuing session of Parliament are unusually numerous. Besides the scheme already referred to for the amalgamation of the Caledonian and North British Railway Companies, there are the following: The acquisition of all the property and powers of the Greenock and Ayrshire Company by the Glasgow and South-Western Railway Company; the Caledonian Additional Powers' Bills, two in number, for forming branch lines, acquiring running powers over the city of Glasgow Union lines, and forming a junction with the Union system on the south side of Glasgow; the North British New Works, &c., Bill; the North Monklands Railways, a new undertaking; the Glasgow and Bothwell line, by a new company; a scheme for forming new branches by the Girvan and Portpatrick Junction Company; one for the formation of the Glencairn Railway and a junction with the Glasgow and South-Western Railway; and an Additional Powers Bill promoted by the Solway Junction Railway Company.

Association of Engineers in Glasgow.—The usual intermediate meeting of this Association was held last week, the President, Mr. John Sutherland, in the chair. Mr. James Gilchrist read an interesting paper on "Marine Slide Valves," in which he alluded to the improved methods of their construction, and illustrated the manner in which the valve faces are sometimes destroyed, assigning the probable reasons for this action. An animated discussion followed, in the course of which many interesting facts were brought under notice.

Fairfield Association.—The fortnightly meeting of this association was held on Thursday evening, the president (Mr Anderson) in the chair. After preliminary proceedings, one of the members opened a discussion on "Steam Jackets" for cylinders, explaining briefly the mode of construction, and dealing more in detail with the advantages, as shown in the indicator diagram, in cases of an early "cut-off." Mr. A. C. Kirk, an honorary member, also gave his views on the subject, showing out clearly many vague points, and dealing with it in a most able manner. After a lively discussion, the meeting was brought to a close by the usual votes of thanks.

Extension of the Finnieston Steamship Works.—A considerable extension of the works of the Finnieston Steamship Company is now in progress. Within the last twelve months a brass foundry and a spacious erecting and fitting shop have been added to these works, and another large addition, which will take the form of stores, &c., is likely to be completed very soon. The Finnieston Steamship Works supply the engines and boilers for the vessels built by the Anchor Line Company, and at the present time they have engines on hand for four large vessels that are building on the Clyde, including the Olympia, which was launched a few days ago from the yard of Messrs. Charles Connal and Company.

New Engineering Contract.—Messrs. Laidlaw and Sons, ironfounders and engineers, Glasgow, have just contracted to build a handsome new iron pier at Hastings. It will be upwards of 900 ft. long, and will be somewhat similar to the piers erected at Brighton and Blackpool by the same firm.

Resumption of a Clyde Shipbuilding Business.—The shipbuilding business, which was established at Govan by the late Mr. John Dobie, and which has been suspended for some time, owing to the death of that gentleman, has been resumed by a new co-partner, consisting of Mr. James Young, who was a long time with the firm of Dobie and Co., and Mr. John William Johnston, son of the late Mr. James Johnston, formerly of the Colpins Iron Works, near St. Petersburg.

RECENT PATENTS.

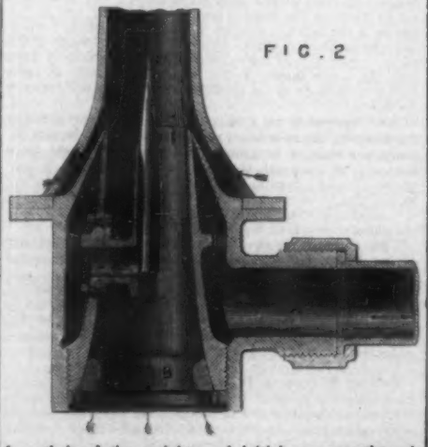
THE following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 3251, 1s. 10d.) George William Hick, of Leeds, patents arrangements of brick and tile making machinery in which the materials are compressed in suitable moulds by hydraulic pressure. We could not describe the details of these plans briefly.

(No. 3255, 1s. 10d.) Charles William Siemens, of 3, Great George-street, patents "constructing apparatus for exhausting receivers, or for compressing or impelling fluids generally in such a manner that steam or other elastic fluid under compression is made to pass through a narrow orifice or orifices opening into a converging passage or passages through which the elastic fluid to be impelled passes, such passage being of sufficient length to cause the two fluids to commingle and to be discharged with a velocity resulting

FIG. 1.

FIG. 2



from their relative weights and initial pressures through a contracted neck into a passage of gradually increasing area, whereby the acquired vis viva is reconverted into a potential force or pressure." The annexed sketch shows one arrangement of steam jet employed by Mr. Siemens, the air inlet openings being marked B, and those for steam A. The patent includes the application of this apparatus for a variety of purposes, such as supplying air to gas producers for generative furnaces, and to pneumatic tubes, &c. Of these various applications we may probably have something to say on a future occasion.

(No. 3266, 8d.) William Robert Lake, of Southampton-buildings, patents, as the agent of Joseph Olmstead, of Chicago, U.S., an arrangement of electric railway brake. According to these plans there is placed on a secondary shaft a wheel carrying electro-magnets, this wheel running freely on the shaft; but being connected by gearing or equivalent means to one of the carriage axles. The secondary shaft also carries an armature wheel which is attracted by the electro-magnets when the latter are put into action, and which when so attracted is caused to revolve with the magnet wheel. The armature wheel as it revolves causes the secondary shaft to revolve with it, and, by winding up a chain coiled on that shaft, applies the brakes.

(No. 3263, .) Frederick Ludewig Hahn Danchell, of Horwich, patents employing for the excavation of peat arrangements of machinery resembling some forms of dredging apparatus now in use, this machinery being either carried on a barge which floats on the water contained in the trench cut in the peat, or being arranged on a platform which travels on wheels.

(No. 3269, 10d.) Frederick Ludewig Hahn Danchell, of Horwich, patents arrangements of cisterns and filters for treating sewage, which we cannot describe here.

(No. 3278, 8d.) John Marshall, of the Glasgow Tube Works, Glasgow, patents several forms of tongs for holding tubes or the strips of which tubes are made during the process of drawing. We have not space to describe these tongs here.

(No. 3282, 8d.) Dougald McCorkindale, of Holytown, patents constructing the fireplaces of puddling and other furnaces so that bars can be introduced above the set in use, and the cleaning of the fire effected by inserting these additional bars and withdrawing those on which the fire originally rested. The patent also includes amongst other details so arranging the flues through which the hot gases pass off from the furnace that the heat of these gases communicated to the air for supporting combustion which is led through parallel flues.

(No. 3286, 10d.) William Allan, of Sunderland, patents fitting surface condensers with scraping plates for removing deposit from the outer surfaces of the tubes. These plates are perforated so that the tubes all pass through them, and they are made capable of sliding to and fro on guide bolts extending from one tube plate to the other. The scraping plates are moved by rods attached to them and led through stuffing boxes in the tube-plates.

A PATENT FUEL COMPANY.—The prospectus has been issued of a company (capital, 100,000*l*.) for the purchase of the Compressed Coal Company's Works at Whitecroft, in the Forest of Dean, for the sum of 30,000*l*. The company propose to manufacture, on a large scale, patent fuel for commercial and domestic purposes; and judging from the results already experimentally obtained, and the large demand for such a fuel as they contemplate producing, the prospects of the company appear to be very favourable.

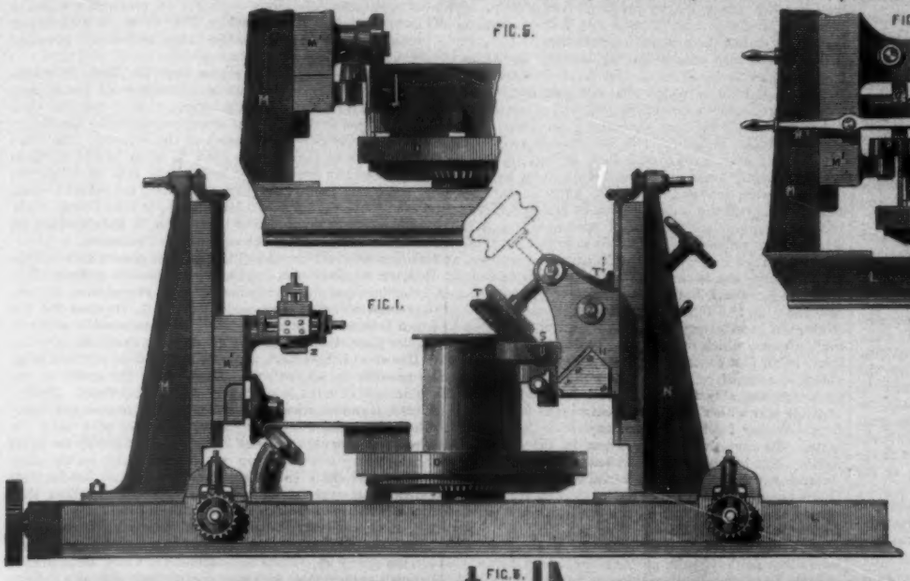
THE SEWAGE OF CAMBRIDGE.—Mr. J. Bailey Denton has issued his report upon the condition of the River Cam and the question of diverting the sewage therefrom. He proposes to take 400 acres of land at Chesterton, and 250 acres at Coldhams Common and Fen Ditton. Referring to the cost, Mr. Denton says that if irrigation be adopted and the maximum quantity of land taken for the purpose, the total outlay, including 400 acres of land, may exceed 70,000*l*. Allusion is made to the sluggish nature of the Cam and the pernicious influence of the locks by which the navigation is maintained. If the liquid refuse of the town is to be purified before entering the river, this cannot be done by simple gravitation, but the sewage must be lifted.

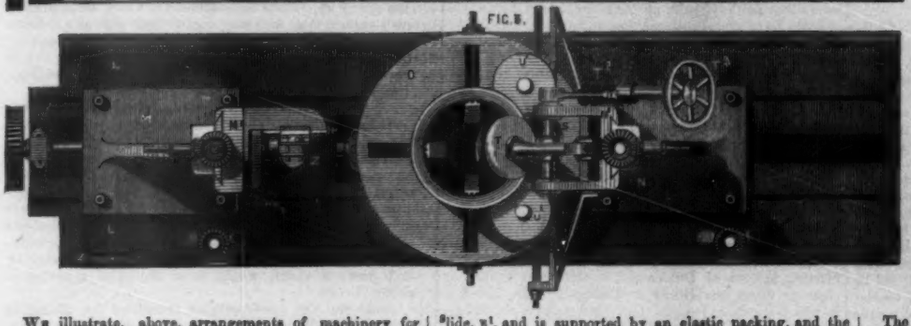
BRIDGING THE SEVERN.—There are now no fewer than six schemes for connecting the opposite shores of the Severn—three by bridges at Sharpness, two by high-level bridges from Tidenham and Caldicot respectively to Almondsbury, and the sixth by tunnel at Portskewet. The fruitless opposition to Mr. Fowler's high-level bridge sanctioned by Parliament six or seven years ago, cost 10,000*l*., and, looking to the ten-fold greater need for now avoiding any obstruction to the free navigation of the river, and the great Parliamentary conflict threatened, the merchants and others are considering calmly whether there cannot be a union of the best points in either scheme, and a second conflict thus avoided.

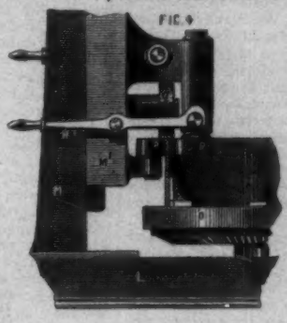
THE MONT CENIS TUNNEL.—The following is an extract from a letter dated Turin, November 12:—"We arrived here at 10 o'clock last night, having been detained an hour and more on this side the Mont Cenis Tunnel. Only fancy, a portion of our passengers was left behind in the middle of the tunnel, owing to the breaking of the couplings of one of the carriages! The fact was not discovered till we had got several miles on this side the tunnel, and we had then to detach our locomotive and send it back to look after our missing carriages. What would an ancient Roman have said if his friend on his arrival had told him that he had been shut up (abandoned) in the earth, 3000 ft. below the apex of Mont Cenis, and brought out alive—the 'earth with its bars round his head?'"

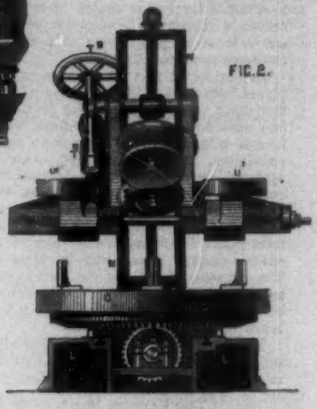
MACHINERY FOR FLANGING BOILER PLATES.

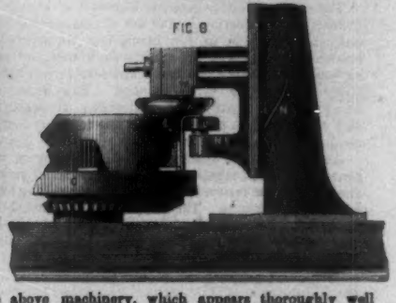
DESIGNED BY MR. DANIEL ADAMSON, ENGINEER, NEWTON MOOR, NEAR MANCHESTER.











We illustrate, above, arrangements of machinery for flanging plates, designed and lately patented by Mr. Daniel Adamson, of Newton Moor, near Manchester, Fig. 1 being an elevation, Fig. 2 an end elevation, and Fig. 3 a plan of the apparatus. In these views, L is the foundation plate to which are bolted the standards, M and N. The positions of these standards can be regulated by the heads of the holding down bolts fitting in the T-grooves in the foundation plate. The standards, M and N, are placed one on each side of the horisontal face plate, O, on which the portion of boiler to be operated upon is secured by four adjustable jaws, as shown. The face plate, O, is turned round by the machinery shown, or in any other convenient manner.

The various rollers for forming the flanges on cylindrical and circular portions of boilers are connected to the standards, M or N; the shape of the rollers and the manner in which they are supported and moved may be considerably modified, but the following arrangements have been found by Mr. Adamson to give good results in practice:—The first operation found requisite is to roll the edge true and to compress or increase its thickness, so that when the flange has been formed by a subsequent operation it may be of the original thickness of the metal or thicker. The rollers, P, Q, and R, for effecting this are shown in Fig. 4; the roller, P, is supposed to revolve in a bearing fixed to the main slide, M^1, which can be raised and lowered to suit the depth of the portion of boiler under operation by a screw and wheels as shown in Fig. 1. The roller, Q, also revolves in a fixed bearing, but the roller, R, must revolve in a bearing hinged to the slide, M^1, so that it may be moved nearer to or further from the roller, P. In operating with these rollers the portion of the boiler with the edge heated is secured on the face plate, O, which is then set in motion. The main slide, M^1, is then lowered until the roller, Q, comes in contact with the heated edge of the plate to be compressed, and the roller, R, is then brought against the inner surface of the plate, in which position it is secured by the catch lever, R^1, or other equivalent. The operation proceeds until the edge of the cylinder is rolled true and the upper portion is sufficiently increased in thickness.

In Fig. 5 is shown a modification of the above arrangement. In this case only two rollers are employed to effect the same or nearly the same object. The roller, P, is similar to that shown in Fig. 4, but the roller, Q, is made of two diameters, the smaller portion acting on the edge of the cylinder and the inside of the larger portion on the inside of the cylinder. When a portion of a boiler has had its edges rolled in the manner above described, the flange may then be bent or formed by the rollers, S and T, shown in Figs. 1, 2, and 3, which rollers have before been used for a similar purpose. The roller, S, is mounted on a stud jointed to the slide, M^1, and is supported by an elastic packing, and the roller, T, is mounted on an arm fixed to the cross shaft, T^2, to which is keyed the toothed quadrant, T^1. This quadrant is driven by the worm, T^3, which is fixed on the same shaft as the hand wheel, T^4. By turning this wheel round, the roller, T, is raised off or brought closer to the roller, S, as may be required.

Before commencing operations the edge of the cylindrical portion of boiler must be heated and the portion secured to the face plate, O, as before described; the standard, N, must then be placed so that the face of the roller, S, is just in contact with the outer diameter of the portion of boiler, and the roller, T, must be so far from the roller, S, that its lower surface may stand above the edge to be turned down to form the flange. The face plate is then set in motion, and the attendant by turning the hand wheel, T^4, gradually brings the groove of the roller, T, against the inside edge of the portion of boiler on the face plate; by continuing the descent of the roller, T, the edge of the cylindrical plate is gradually bent over the angle-shaped roller, S, until it stands at right angles to the body of the cylindrical plate, thereby forming the flange.

Fig. 6 represents an arrangement of rollers for forming the flange on the cylindrical portion of a boiler. In this instance the roller, U, is mounted on a stud fixed to the main slide, M^1, and the roller, W, which has a bevel surface, is supported on a stud fixed to the slide, W^1. This slide is moved to and fro by a screw. When the heated cylindrical plate is secured to the face plate, the roller, W, is brought within the plate, and it is then gradually forced outwards so as to bring the bevelled edge of the roller against the heated edge of the plate which is thus turned over and formed into a flange on the top of the roller, W.

Fig. 7 represents a pair of rollers, V, V^1, suitable for making the semi-corrugated joints, which Mr. Adamson proposes to use in some cases for the transverse seams of boilers. The roller, V, is mounted on a stud fixed to the slide, M^1, and the roller, V^1, is mounted on an arm in the same manner, as the roller, T, in Fig. 1, or on a slide as the roller, W, in Fig. 6. In rolling the flange on cylindrical plates they are steadied by the adjustable guide rollers, U^1, see Figs. 1, 2, and 3.

The machinery above described may also be used for making the flange on the circular plates forming the ends and other parts of boilers. To effect this Mr. Adamson employs the rollers, Y and Y^1, see Fig. 1. The former is mounted on a stud fixed to the slide, M^1, and the latter is on a stud projecting from the standard, Y^2, which is secured to the foundation plate, L. The circular plate to be operated upon is secured to and revolves with the face plate, O, and the heated edge is bent over the roller, Y^1, by the descent of the roller, Y.

The above machinery, which appears thoroughly well designed for its purpose, is also adapted for turning up the ends of the circular portions of boilers by applying cutting tools to the rest, Z, the said rest being supported in a cross slide connected to the main slide, M^1, of the standard, M or N, the portion of boiler being secured to and revolving with the face plate, O.

The P. and O.—With the view of improving their present mail service between England and Australia, the directors of the Peninsular and Oriental Steam Navigation Company are stated to have determined to place their fine ships Pera and Ceylon on the line between Galle and Sydney. These vessels will carry a considerable number of passengers, and they steam fast.

Canadian Railways.—The estimated cost of carrying out the Canadian Pacific Railway is 20,000,000*l.* Application is to be made to the Quebec Parliament for an Act to incorporate a company to construct and work a railway from the waters of Missisquoi Bay, or some point in St. Armand West, passing through the village of Phillipsburg, to connect with the St. Lawrence at or near St. Lambert. The Toronto, Grey, and Bruce Railway is now finished to Arthur, 73 miles from Toronto. Mr. Sandford Fleming has returned from an inspection of the Intercolonial Railway.

Belgian State Railways.—The Belgian Department of Public Works has applied to the chambers for a credit of 483,200*l.*, of which all but 12,000*l.* is to be applied to the improvement of the plant and repairing shops of the Belgian state lines. Of this amount 40,000*l.* is to be applied to the construction of new shedding for locomotives and 431,200*l.* to the purchase of additional rolling stock. Of the 431,200*l.* to be devoted to the purchase of new plant, 174,000*l.* will be absorbed under the head of locomotives, viz., 58 locomotives with tenders and 30 tenders for locomotives supplied previously without tenders.

Iron Shipbuilding in the United States.—It appears from an official return that in 1867 no iron ships were built in the United States. In 1868 6 were constructed of an aggregate burthen of 2201 tons; in 1869 10 of an aggregate burthen of 4564 tons; in 1870 15 of an aggregate burthen of 8281 tons; and thus far in 1871 20 of an aggregate burthen of 15,479 tons. This gives a total of 51 iron vessels of an aggregate burthen of 31,145 tons built in the United States within the last four years. Of 20 iron vessels built in the United States during twelve months ending Jan. 31, 1871, 19 were steamers.

NOTES FROM PARIS.

PARIS, Nov. 20, 1871.

Electric Brake for Power Looms.

M. Richard has presented to the *Société* d'Encouragement a system of electric brake applicable to stocking or weaving looms. The report of MM. Alcan and du Moncel points out several interesting novelties in this invention. The system of thread brakes employed at present, and in which the employment of electricity already enters, stops the loom when the thread is broken; the new apparatus does more; it stops the machine before the rupture, and reduces the tension in the thread to a certain limit; it may be when the rupture is imminent, it may be when the bobbin is almost divided; the same effect is also produced every time that a large knot occurs in the thread, or when the bobbin is irregular or too tight, or when an obstacle of any nature increases the tension to a dangerous extent, and threatens to rupture the thread.

The principal part of the apparatus is a light frame placed horizontally, jointed at one of its extremities, and the other extremity of which is able to move between two studs forming electric contact, the stretched thread frames bringing a slight pressure against the movable extremity. A coiled spring, of which the tension equilibrates the pressure that the thread, in its normal state, exercises on the frame, maintains the latter oscillating in the free space between the frames. So when the tension of the thread diminishes or increases beyond the fixed limits, the frame touches one of the two studs, the electric current passes, and actuates an electro-magnet. The armature of this magnet puts in movement the brake apparatus, and the loom stops before an accident to the thread can produce any disorder in the working of the loom.

The application to stocking looms has been made with success. The reporters consider that the same arrangement will give good results in ordinary power looms.

The Eastern Railway of France.

The company of the Eastern Railway of France held its general yearly meeting on the 4th of this month, after two postponements due to the insufficient number of shareholders present. The eastern network was the one that suffered most during the war. The service was almost entirely stopped for seven months. The Prussians took away large quantities of materials; stations, bridges, and viaducts were destroyed, and the company lost its concessions in Alsace and Lorraine.

According to the detailed estimate of damages, the sum necessary for the repairs amounts to 7,800,000 francs, and the expense for restoring the whole of the rolling stock will be 8,100,000 francs. The part of the line ceded to Germany has a total length of 520 miles, and by this loss the company is deprived of its direct communication with Switzerland, and the neighbouring district which fed its traffic. The company claim from the Government, besides the maintenance of the financial guarantees effected by the loss of the Alsatian *réseau*, the concession with subventions of several lines joining up the branches of the remaining system in the neighbourhood of the new frontier. The company, in place of accepting simply the indemnity of 325 millions of francs, stipulated for in the treaty of peace, prefer to negotiate with the Government for special conventions, by which they hope to secure to the shareholders in the future dividends equal to those of past years.

The Metallic Mines of France.

M. Caillaux has just presented to the Société des Ingénieurs Civils a very interesting work on the metallic mines of France. This work is divided into two parts—the history of mines from the time of the Gauls to the present day, and a description of some measures of order and principle, which it would be useful to apply to obtain a more easy working of mines. The book is accompanied by several statistical tables showing the always increasing value of metals imported into France—of values which during the last few years have risen enormously—and a description of metallic mines being worked from 1836 to 1864, and the unworked mines which during this period have always represented more than half the total number of concessions, and particulars of the production of French mines from 1816 to 1864.

M. Caillaux, after the complete and valuable statements of facts of which we have only been able to give the briefest summary, arrives at the following conclusions:

1. That the greater part of mines, at one time worked with great success, have been on the decline since 1810, the epoch when the law which stills governs mines was promulgated.

2. That the metallic resources of France have not been properly worked during this century.

3. That France should be a rich producer of metals. Great things could be done with the metallic formation, and most of the metals imported could be obtained at home. In effecting this, numerous elements of work and fortune would be found, for the disfavour which weighs heavily upon this class of mines is not justifiable.

Taking the whole of France we find 70,000 square miles, beneath which metallic deposits may be found. In the five mountainous groups of the country we recognise the same rocks found in England, in Spain, and in Germany. We know of many thermal springs, and of numerous quartz ore veins always met with in the most metalliferous districts.

Moreover, we may point to the presence of a large number of old works, which are seen to-day on the summits and the sides of mountains, and which show that France has been in other times largely productive of metals. And, lastly, it is shown that it was not from exhaution of the workings that these mines were abandoned.

During the 19th century mining industry in France has been comparatively at a standstill. Submitted to the legislation of 1810, of which the first principle consists in considering the mines as forming part of the royal domain, it has only made progress since the year 1850. We see that the mining industries felt the influence of the rapid development of railways, and that to-day, there is a tendency to improvement, but whilst the great mining discoveries in America and Australia, were followed by increased energy in the same direction in England, Germany, and Sardinia, and whilst general commerce and industry increased in proportion previously unknown, the mining works of France progressed with extreme slowness, and presented frequent examples of failure and abandonment.

M. Caillaux attributes the situation to many causes, especially to the following; the inexperience in mining works, and insufficiency of the funds applied to such works; the ignorance which exists among capitalists and manufacturers in all that concerns mining operations; the too great extent of concessions, from which results that concessionaires are not able to draw a full advantage from the districts over which they hold control, and prevent others from bringing intelligence and capital to bear on their mines; the excessive difficulties put in the way by legislation; the incomplete application of the clause of the statute, which brings back abandoned mines into the public domain. Concessions not worked by the proprietors remain also valueless, and other speculators are prevented from offering themselves.

M. Caillaux, after having presented all these examples, shows that neither Spain, nor England, nor America, could possibly have ever become great metal producers, if they had submitted to a régime similar to that existing in France, and he insists on the necessity of modifying the existing law. He proposes several measures tending to give a greater publicity to everything concerning mines, he indicates the principal points that it would be important to modify in the existing mining laws, and he asks if the metallic resources of France should not be confided to the general administration of the departments, instead of being concentrated in the central power.

New Filtering Process.

The water works of Dunkerque, completed in 1870, include the application of a filtering process, arranged by M. Pauwels, the city engineer, in charge of the works. The filtering system of Dunkerque is analogous to the self-cleaning filters established at Paisley by Mr. Thom, and in which the duty is equal to 27,500 gallons per 24 hours, with an area of 7100 square feet.

The total thickness of M. Pauwels' filter is only 26 in., arranged as follows:

in.			in.
5.124	Formation	Bricks laid on edge	
1.194		Tiles set in Portland cement	18.118
5.900		Calais gravel	
5.900		Culm	
7.882		Filtering bed of fine sand	7.882
26.000		Total thickness in inches.	26.000

The 5.9 in. of culm in the formation is laid in three beds, in which the fragments decrease in size from the bottom to the top. This material has given good results, allowing the water to flow through, and being absolutely impermeable to the grains of sand which form the upper bed. The gravel, on the contrary, allows the sand to pass gradually, gets choked rapidly, and reduces the useful effect of the filter. The duty of the filter reaches the proportion of 8 cube metres to 1 square metre per 12 hours.

It is well known that in a certain number of localities the results of filtration have not been entirely satisfactory. M. Pauwels believes that he has overcome all difficulties by the combination he has adopted, that is, by the use of the beds of coal-dust under the layer of sand.

French Engineers.

We have had occasion to explain how the situation of the Ingénieurs des Ponts et Chaussées has found itself threatened by the new law, on the authority of the General Councils, who are free now to confer upon whoever they may think fit the administration of the roads of the departments, which were, till now, confided to the Ingénieurs des Ponts et Chaussées. And now a new attack is made against this corps of privileged engineers, this time originating with the society of civil engineers. Some propositions presented by M. Molinos have been considered by the Committee of the Society at several meetings, and a complete report was submitted at the last assembly for the consideration of the members of the society, and for subsequent discussion.

It is well known that the State accepts as engineers for the numerous branches of its service only the old pupils of the Ecole Polytechnique. Entry to this school is possible only up to 20 years of age, after a difficult examination, new examinations follow after two years of study, after which the students are classified according to merit. The twenty or thirty leaders become Government engineers for mines, bridges, roads, manufactories, telegraphs, &c., the others are distributed generally in the artillery and civil engineering services. After passing three years in a special school of application, the State engineers are necessarily called to exercise their several vocations. They carry out without any interference the various public duties, and receive advancement with length of service.

The report alluded to shows that the Ecole Polytechnique, while giving scientific instruction of the highest class, has become very exclusive; that it supplies each year only a limited number of engineers, totally insufficient for the industrial requirements of the country. Since the instruction of the school is good, it must benefit all those who, by their preparatory studies, are able to follow the course with profit. In place of opening the school to some young men of 20 years, and keeping it closed to all those who would later be able to profit by it, it should admit all those who can satisfy the conditions of entrance.

The mode of recruiting the State engineers stands alone in the whole of the French administrative system. It is not thus that the Government chooses magistrates, doctors, professors, and functionaries which it requires for the public service. It is open to all who are capable, and who give proof of their capacity by certain examinations to obtain any of these posts, only the situation of engineer is inaccessible to all those who do not enter the career by the one door of admission—the Ecole Polytechnique. Besides certain examinations passed through at the commencement of life, are not a sure criterion of the value of a man. It often happens that men at 30 years do not justify the hopes which they had given ten years before, and, on the other hand, one often finds men whose intellectual development has been more slow, assume a capacity of which they would not have been suspected in their youth.

A violent effort is demanded of young engineers at the outset of their career, which is often beyond their force. They freely appreciate the sentiment of a task accomplished and a reward won, and they regard their title as a definite conquest, which could never be attacked without injustice, and thus the State engineer is fitted for his post. Then once established, the lack of emulation, and the certainty of advancement removes all stimulus to activity.

The report proposes for the reform of these inconveniences the following remedies. The Ecole Polytechnique should be developed into a kind of free faculty, where necessary instruction to engineers should be given to all those candidates who can pass the preliminary examination. The school would award grades of merit simply, not confer employment. The State would give posts to engineers who are proved most capable, either in choosing amongst the students who hold the Polytechnique diplomas, or in selecting indiscriminately amongst engineers whose capacity, tested by their previous works, would form the chief criterion of ability.

Such are the considerations submitted for discussion amongst the civil engineers; they have evidently a double object—to expand scientific instruction, and to recruit the Government engineering staff, after a system at once more equitable, and more beneficial to the public service.

Defences of Malta.—It appears to be seriously intended to put the fortress of Malta in an efficient state of defence. Important works have been, or are about to be commenced by the Royal Engineer Department on the Corrodino Hill for the protection of the dockyard. Other extensive works for strengthening the fortifications on the land front—chiefly by means of outlying forts on the surrounding hills—are reported to be in contemplation. The construction of tanks within the fortifications, capable of supplying the garrison in case of siege with water for five years, has also been determined on.

Tramway Traffic.—The extent to which the tramway traffic in South London has grown can be judged from the fact that in connexion with the Blackfriars and Westminster lines to Greenwich, Camberwell, and Brixton, 45 cars are running daily. At St. George's-circus, at the top of Blackfriars-road, the point of convergence for all the cars starting from and returning to Blackfriars and Westminster Bridges, with the exception of those on the direct line from Westminster to Clapham and Brixton, the cars in the aggregate pass 441 times a day, that being the number of journeys performed daily by the 45 engaged. Twenty-four cars on the Greenwich line make seven journeys each daily, or 168 in all; while nine cars on the Brixton line make 11 journeys each, or 99 during the day.

Sea Baths for London.—A project for supplying London with sea water has been started by a company, which is about to apply to Parliament for incorporation, and for the necessary powers to effect its object. It is proposed to bring the water from the neighbourhood of Brighton by means of nine reservoirs and ten conduits and pumping stations, which are to be constructed *en route* at Aldrington, Preston, Patcham, Newtimber, and Cuckfield, in Sussex; Merstham, Surrey; Hendon-street and Vauxhall Bridge-road, St. George's, Hanover-square, and in Moore-street, St. Luke's, Chelsea. The company propose, further, to construct public and other baths, and to supply sea-water to Brighton itself and other enumerated localities, and to any parish or place within the limits of the metropolis district, as defined by the "Metropolis Local Management Act."

GERMAN RAILWAYS.

THE CONSTRUCTION AND MAINTENANCE OF PERMANENT WAY.

(*Continued from page 296.*)

IRON RAILS WITH STEEL TOPS.

FURTHER observations on the use of iron rails with steel tops have been made by the administrations of seven German railways. The worn-out rails with steel tops on the Saarbrück-Trier Railway showed tops more or less flattened, as well as in some cases exfoliations and longitudinal cracks. The administrations of three railways report favourably on the use of these rails, whilst those of three other companies state that in their opinion iron rails with steel tops are inferior to cast-steel rails, as regards their power of withstanding wear and tear, and that as the difference between the prices of the two kinds of rails is very small, no sufficient reason seems to exist why iron rails with steel tops only should be used instead of rails made entirely of steel.

The Hessian Northern Railway, the Saxon State Railways, and the Bergisch-Märkisch Railway have all used rails with steel tops, and have obtained satisfactory results; the administrative officers of the Saxon State Railways state expressly that the rails used on their lines have been all that could be desired, especially with respect to the welding of the iron and steel. It appears from these reports, that rails with steel tops, if carefully manufactured, may be used without disadvantage; the tops being but slowly and uniformly worn off, and any premature renewal of the rails being mostly caused by a defective welding of the steel with the iron. In such cases the steel top gradually leaves the iron, cracks becoming visible at the central part of the rail and extending gradually towards the end; the first sign of a bad welding is a dark discolouration of the web beneath the welded seam. Table No. IV. on the present and following pages, gives details of the results obtained with steel-headed iron rails on the various lines above referred to.

INFLUENCE OF THE NOTCHING OF RAILS.

The administrations of several railways have again reported on the necessity of notching the bottom flanges of rails, and it is stated by one railway company that on a line laid with cast-steel rails without notched bases a dangerous longitudinal shifting of the rails has been observed, and that a remedy for preventing this disturbance has not yet been found. The officers of the Kaiser-Ferdinand Northern Railway, the Westphalian Railway, and the Nassau Railway state, however, that they do not consider the notching of the bases of rails at all necessary if properly arranged joints are adopted: the first named railway has used off-set plates as

TABLE No. IV. SHOWING THE RESULTS OBTAINED WITH RAILS WITH STEEL TOPS.

Reference Number.	Name of railway on which the rails were used.	Name of works from which the rails were supplied.	Quantity supplied.	Weight of rails per yard.	Height of rails.	Length of line over which the rails have been laid down.	Nature of line on which the rails have been laid.			Average number of years during which the rails have been under traffic.	Period of guarantee.	Percentage of the total number of rails which have had to be renewed during the period guaranteed.	Percentage of the total number of rails which have had to be renewed since they were first laid down.	REMARKS.
							Radii of curves.	Gradients.	Average daily number of trains.					
							A. *Rails with Puddled Steel Tops.*							
			tons.	lb.	in.	miles.	feet.			years.	yr.	per cent.	per cent.	
1	Altona-Kiel Railway.	Funke and Elbers of Hagen.	207.1	72.32	4.5	1.260	2350	1 in 400	4 to 10	3	10	0.7	0.7	The rails 4.65 in. in height are laid down upon the Hamburg district of the Altona-Hamburg junction. They have the same section as the new rails of the Berlin-Hamburg Railway, and are already a little worn in the sharp curves of 922 ft. radius. The damage of the renewed rails consists of flattened tops.
			474.4	...	...	4.633	...	...	...	1	...	...	...	
			87.6	81.62	4.65	0.726	922	1 in 80	15	8	5	7.4	7.4	
			32.6	...	...	0.311	...	...	...	1	...	...	...	
2	Bebra-Hanau Railway.	Funke and Elbers of Hagen.	135.	79.	5.	1.181	3722	Horizontal after preceding gradients of 1 in 100	18	4½	5	...	2.0	13 rails.
		Steinhauser Hütte	425.	...	...	3.720	...	...	...	¼				
3	Berlin-Anhalt Railway.	Funke and Elbers of Hagen	16.2	80.	4.8	0.053	1961	1 in ∞	14	2	...	...	2.5	
						0.067	922 to 929	1 in ∞ and 1 in 480	Station	1½				
4	Berlin-Hamburg Railway.	Arndt of Dortmund	1119.5	83.3		9.104	3094 to 12,470	1 in 556 to 9000	15	5	5	3.32	3.32	The period of guarantee had not yet expired.
		Funke and Elbers, Hagen	2176.	84.2	4.72	17.909	3712 to 12,470	1 in 300 to 16,000	15	5	5	0.02	0.02	The damage consists mostly of flattened tops and a peeling off of the head of the rails.
		Phœnix-Hütte, Ruhrort	6708.25	81.5		53,039	3094 to 12,470	1 in 300 to 16,000	15	5	5	0.02	0.02	
5	Berlin-Stettin Railway.	Hörder Hütte	41.2	82.72	5.2	0.141	1654	1 in 360	9	4	5	...	...	There are two lines of rails, and the rails in question are mostly laid down upon the outer sides, only a fourth of them being placed on the inner sides of the curves. Only one rail shows a flattened place on the top, but a slight peeling off has been observed on several other rails.
6	Leipsic-Dresden Railway.	Queen Marie Hütte, near Zwickau	1019.	72.	4.6	2.718	3715	1 in 200	15 to 20	8	5	4.5	9.0	Bad welding of the steel top.
		Hörder Hütte	2.53	83.3		0.010	1236.5	...	10	2½	5	...	...	No faults.
7	Lower Silesian Railway.	Funke and Elbers, Hagen	28.3	...	5.2	0.234	4264	1 in 300	13	5	5	4.54	...	Flattened tops and longitudinal cracks over 2 and 6 ft.
		E. Hoech and Sons	101.9	...		0.633	3785	1 in 300	13	2½	5	3.67	...	Flattening and peeling off of the top edges.
8	Upper Silesian Railway.	Phœnix-Ruhrort Aix-la-Chapelle Association Funke and Elbers, Hagen Roetz Zu Rothe Erde, near Aix-la-Chapelle	471.3	84.4	5.2	3.878	4836	1 in 360	34 to 44	1	5	0.1	0.1	
9	Eastern Railway of Prussia.	Hörder Hütte	25.5	83.4	5.2	0.208	...	...	Shunting line near station	5	5	...	...	No faults.
10	Western State Railway of Saxony.	Carl Asbeck and Co., Hagen	87.86	70.	4.6	0.372	1843	1 in 1000	56 to 58	8	4	1.580	15.313	Laid down in 1859.
		Queen Marie Hütte, near Zwickau	6.79			0.067	1843 and 2210	1 in 100	56 to 58	7	4	4.589	7.402	„ „ 1860.
		Carl Asbeck and Co., Hagen	8.00			0.080	737; 3715 and straight	1 in 100; 1 in 40	30	7	4	10.4	98.0	
		„ „	19.41			0.164	do.	1 in 250	20 and empty wagons	5	4	9.5	11.4	
		„ „	11.48			0.168	do.	1 in ∞	20	4	4	...	0.2	Many bad places of welding are visible in the tops of the rails.
		Queen Marie Hütte, Zwickau	4.25			0.035	do.	1 in 250	20 and empty wagons	5	4	...	23.5	
		„ „	6.10			0.064	do.	1 in ∞	20	½	5	...	...	
		Funke and Hueg, Hagen	8.56			0.077	do.	1 in 250	20 and empty wagons	5	4	...	13.1	
			94.38			0.949	2974 and 6630	1 in 200, 1 in 2400	14 to 70	0.75	5			
			13.10			0.132	2762	1 in 3000	10	0.25	5			
11	Eastern State Railway of Saxony.	New Scotland, near Steele	113.53	71.	4.65	1.105	2762	1 in 90, 1 in 140	11	0.16	5	0.15	0.15	Unsatisfactory welding between steel and iron: the steel tops had been entirely separated from the iron.
			56.65			0.576	2940	1 in 200	20	1.00	5	3.10	0.10	
			63.85			1.104	920 and 1155	1 in 40, 1 in 50	6	0.25	5	...	...	No damage has been observed; rails are only in use three months.
12	Kaiserin Elisabeth Western Railway (Austria.)	Reschitza in the Banat	338.5	80.	4.85	2.033	Straight lines and curves of 1242 to 27,251 feet radius	Horizontal and gradients of 1 in 100 to 1 in 1175	14	2½	7	1.592	1.592	Separation of steel top from iron central web.
		„ „	1546.17			16.060			15	1½	7	0.346	0.385	
		Rossitz, near Brünn	333.6			2.054			24	2½	7	5.214	5.214	
		Count Henkel of Zeltweg, and Zwischenbrücken	3498.0			29.441			16	1	7	3.359	3.359	
		Totals ...	19236.35	...	...	161.211								

TABLE No. IV.—*Continued.*

Reference Number.	Name of railway on which the rails were used.	Name of works from which the rails were supplied.	Quantity supplied.	Weight of rails per yard.	Height of rails.	Length of line over which the rails have been laid down.	Nature of line on which the rails have been laid. Radii of curves.	Gradients.	Average daily number of trains.	Average number of years during which the rails have been under traffic.	Period of guarantee.	Percentage of the total number of rails which had to be renewed during the period guaranteed.	Percentage of the total number of rails which have had to be renewed since they were first laid down.	Remarks.
			tons	lb.	in.	miles	feet			years.	yrs	per cent.	per cent.	
							B. *With Cast-Steel Top.*							
1	Lower Silesian Railway	Hörder Hütte	66.4	84.4	5.2	0.599	3450	1 in 200 to 1 in 800	6 to 24	2	7	...	...	The last supply of about 45 tons shows many soft places, whence the wear and tear is not uniform.
5	Eastern Railway of Prussia	Hörder Hütte	23.0	84.8	5.2	0.127	...	...	shunting line near station	2½	5	...	...	No faults.
		Total	89.4	...	...	0.726								
							C. *With Bessemer Steel Top.*							
1	Altona-Kiel Railway	Dowlais Iron Works	18.8	72.32	4.5	0.180	1474	1 in 140	6 to 15	4	5			
			21.58	...	...	0.206	...	...	...	1				
2	Lower Silesian Railway	Hörder Hütte	7.42	83.3	5.2	0.061	...	...	20	1½	7	...	...	Tops stand well; other parts show soft places.
3	Western State Railway of Saxony	Queen Marie Hütte near Zwickau	89.00	70.	4.6	0.868	660, 2715, and straight	1 in 110, 1 in 200	26 and 34	1	5			
			38.731	71.2		0.384	6630	1 in 2460	14	0.75	5			
			35.40	...		0.357	6230 and 3730	1 in 1000, 1 in 3000	10	0.25	5			
4	Eastern State Railway of Saxony	" "	22.70	...	4.65	0.220	5524 and 2762	1 in 140, 1 in 200	11	0.5	5			
			25.06	...		0.254	1349	1 in 160	40	0.33	5	0.68	0.68	Separation of the tops; fault in rolling.
			125.00	71.2		1.261	920, 1105, 3720	1 in 40	8	0.5	5	0.356	0.356	No damage has been observed. Rails in use only four months.
6	Wurtemburg State Railway	Hörder Hütte	101.3	80.3	4.5	0.786	980	1 in 45 over the whole length	At least 13, and as many pilot engines	1½	5	1 rail equal 0.005	1 rail equal 0.005	Bad places in the web.
6	Kaiserin Elizabeth Railway (Austria)	Iron Works of the Southern Railway of Austria, near Gratz	14.18	80.	4.65	0.123	2170	Horizontal	20	2½	7	17.143	17.143	Separation of top from web.
			17.85			0.150	927	1 in 1000	12	3	...	...	15	
			7.46			0.062	...	1 in 40	30	3	...	...	54	Peeling off of top.
			16.64			0.148	629	1 in 45	12	3	...	...	25	
			154.40			1.112	629 and 927	1 in 40, and 1 in 45	12	1½	3	...	0.20	
7	Southern Railway of Austria	" "	36.15	81.36	5.	0.308	straight	Horizontal	18	2½	3	...	...	
			12311.00			104.160	927	1 in 40	6	½	3	...	0.4130	Of the 0.413 per cent. of the rails which had to be renewed, only 0.0413 per cent. showed a bad welding between iron and steel. The remainder of the rails, 0.37 per cent. were renewed on account of other injuries to the material.
		Totals	1 942.741	...	...	110.641								

a successful preventative of longitudinal movement.

Of the twelve administrations which have reported on the influence of the notching of the rails upon the durability of the latter, eight state that no disadvantageous effect of the notching has been observed; but the reports of four other administrations affirm that fractures of cast-steel rails at the points where they are notched have frequently occurred, not only through careless handling of the rails, but also very often under traffic. The Nassau Railway Company recommends an oval shape for the notches, and the Rhenish Railway considers the rounding off of the corners of the notches to be the cause of the success with which notched steel rails have been used on that railway.

Recapitulation.

The continued observations carried out during the last two years on the railways of the German Association with respect to the advantages or disadvantages connected with the use of the different classes of steel rails, have not yet been made sufficiently complete to enable a final conclusion to be arrived at with respect to the relative value of rails made of various materials. The further use, however, of steel rails is earnestly recommended by the association, for even the short time during which these rails have been under traffic sufficiently proves that they will be less expensive and better than other rails, especially if care is taken to make them of homogeneous material, free from brittleness. They also affirm that steel rails with wrought-iron bases may also be used, if the welding between iron and steel has been successfully performed; but we ourselves see no reason for employing them in preference to steel rails.

With regard to the notching of cast-steel rails, it may be said that most of the reports, although they give very different results, have not confirmed the idea that the practice is injurious. Considering that nothing equally convenient has been proposed, the association does not recommend the railways connected with it to give up the notching of rails; but it states that the notching might be done, however, at the ends of the rails only and that the corners of the notch ought to be carefully rounded off.

(*To be continued.*)

RAILWAY BRIDGE SHOWER BATHS.

Having occasionally been compelled to take an involuntary shower bath whilst passing under some of our metropolitan railway bridges, it is with some degree of satisfaction that we observe that the matter is about to be warmly taken up. In the early part of the present year the Court of Common Council of the City and the Lambeth vestry had severally debated what course could be taken with the London, Chatham, and Dover Railway Company in the matter. The Lambeth vestry sent in a strong remonstrance to the London, Chatham, and Dover Railway Company with regard to several dripping bridges in their parish. They appear also to have used every effort to induce the railway company to prevent the percolation of water through their bridges, but without effect. Consequently, at a recent meeting of the vestry, it was resolved that immediate legal proceedings by indictment should be taken to effect an object which remonstrance and persuasion have failed to secure to the public. This step is not to be wondered at, as the nuisance complained of is intolerable, and the company have treated the remonstrances of the vestry with silent indifference.

It is to be remembered that this dripping takes place not only during the continuance of rain, but goes on long after its cessation, and there are few metropolitan bridges under which a number of water-worn holes are not to be found, which are occasioned by the heavy dripping constantly going on. Between these droppings foot passengers have to dodge, whilst riders are drawn through the little torrents *nolens volens*. The action of these droppings is by no means improving to male clothing, whilst to ladies' dresses it is most damaging, for it is not pure water that makes itself seen and felt, but a mixture of water, iron-rust, and ballast washings, with sometimes a dash of oil from the railway plant. It is therefore but right that the public should be protected from a nuisance which was justly described at the vestry meeting as "abominable."

It must, however, be borne in mind that there are two sides to the question, and we have now to look at that of the railways. As a matter of fact numberless expedients have been resorted to from time to time in order to prevent leakage on the Metropolitan Railway bridges. These of course are matters of detail in construction, and engineers have used india-rubber packing, felt, patent composition, asphalte, &c., &c., in the endeavour to render the platform of the bridge water-tight. Their attempts, however, have been fruitless, as the vibratory action of the trains soon produced innumerable ways of escape for the drainage water through ballasting, platform, and girders down to the public way below. It having been found practically useless to attempt to stop this leakage the engineer of the South-Western Railway had a corrugated iron covering put up under the girders of some of the bridges of that line. This expedient answers well as it catches the droppings which are conveyed to gutters and thence by down pipes to the road instead of being allowed to patter down upon the heads of the public. And this is really the only practical method of treating the nuisance: the leakage cannot be prevented from above the bridge, let it therefore be dealt with from beneath it. We observe that the London, Chatham, and Dover Railway Company have partially carried out this idea in one or two bridges by placing the gutters along the edges of some of the main girder flanges, and carrying the droppings by these to transverse guttering fixed at the springing of the ribs and leading to down-pipes. But this is not enough; to render this plan effectual a perfect network of gutters would be necessary, and even then the droppings would probably find their way through the meshes. The corrugated covering is the proper thing, and in this railway companies will find a remedy for their defective bridges. Some very bad examples of leaky bridges are to be found on the Charing Cross line, notoriously the land span of Hungerford Bridge. Here passengers on the Thames Embankment may occasionally be treated to a perfect drenching. Nor are steamboat passengers better off, as the river spans are equally defective.

Seeing, however, that there is a remedy, and that a simple and inexpensive one, we fully endorse the procedure of the Lambeth vestry. Before, however, any action is taken we trust that railway companies will recognise the propriety, as well as the necessity, of putting up carriers for the water as a protection to the public. Travellers overhead are hardly to be accommodated at the expense of those underneath, and no company can possibly resist or object on the score of expense, for those that do so, especially the London, Chatham, and Dover Railway Company, must inevitably be convicted of straining at gnats after having swallowed camels.

Paper Car-wheels.—A set of paper car-wheels on one of the Pullman cars running to Jersey City have run over 160,000 miles of track, and worn out entirely one set of steel tyres, which have been replaced. The ordinary wheels will only run 60,000 miles.

COMPARATIVE TABLE OF EXPENDITURE ON CARRIAGE AND WAGON REPAIRS AND RENEWALS ON THE UNDERMENTIONED RAILWAYS.

Half-year ending June 30th, 1871.

| COMPANY. | Working stock. | | | | | Ordinary Expenditure. | | | | |

APPARATUS FOR MEASURING THE RADIANT INTENSITY TRANSMITTED BY FLAMES.

CONSTRUCTED BY CAPTAIN JOHN ERICSSON.

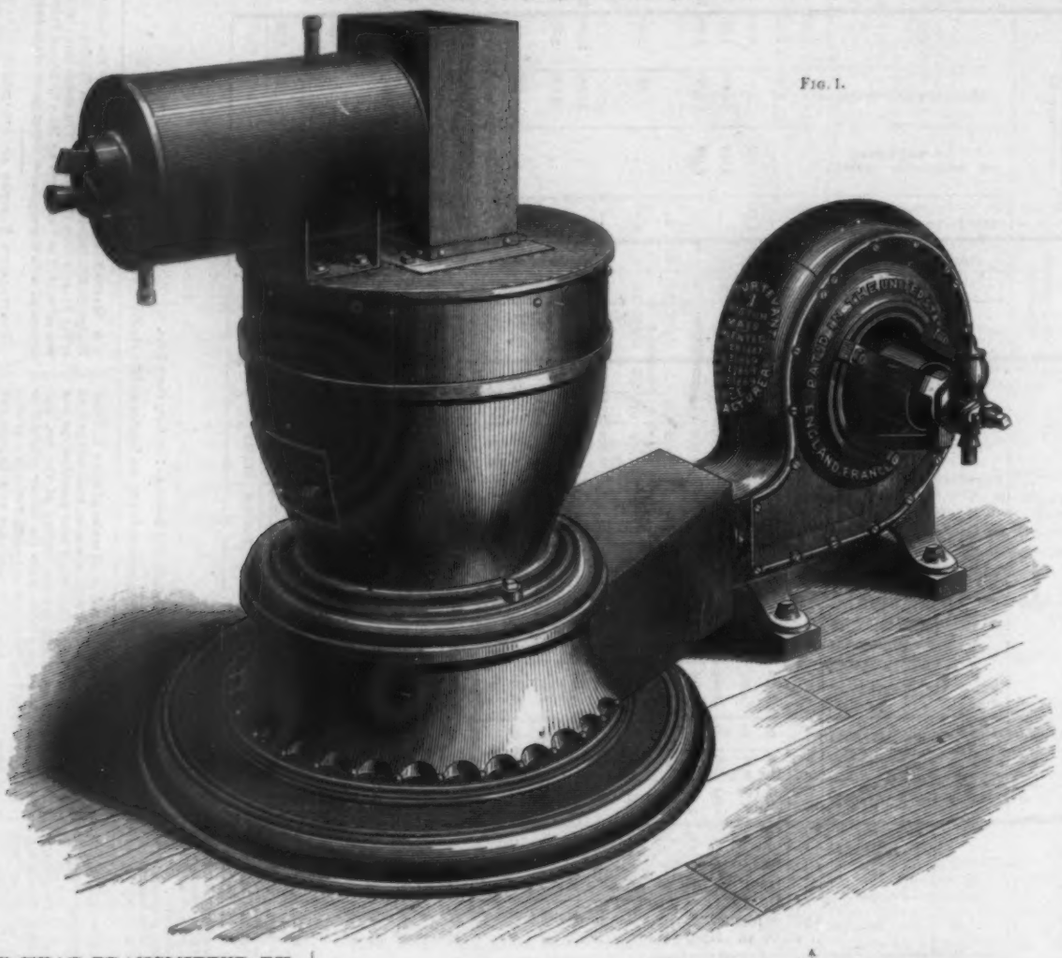


Fig. 1.

RADIANT HEAT TRANSMITTED BY FLAMES.

By Captain John Ericsson.

The temperature produced by the radiation of flames, is a subject of far greater importance than generally supposed. Some distinguished physicists imagine that the radiant power of flames is considerably less than that of incandescent solid substances, contending that it is impossible to ascertain the temperature of the sun because the radiant heat transmitted is the result of the radiation of the incandescent gases of the photosphere. The accompanying illustration, Fig. 1, represents an apparatus originally constructed to demonstrate the unsoundness of this assumption, and to prove that the radiant power of flame is not less than that of incandescent solid bodies. In a practical point of view, an exact knowledge of the temperature produced by the radiant heat transmitted by flames, is of great importance, as it furnishes means of measuring with desirable precision, temperatures which the nature of the materials at our command renders it impossible to ascertain by direct contact. It was shown in the article on Solar Heat, published in Engineering, December 30, 1870, that the intensities of circular radiators of *different* size, imparting equal temperature at *equal* distance from the radiating surface, are inversely as the squares of the sines of half of the subtended angles, that is, the angles formed by the axes of the circular radiant surfaces and the heat rays projected from the circumferences to the substance receiving the radiant heat, in the prolongation of the axes. It will be evident on reflection that, agreeable to this proposition, it is possible to determine the temperature of an inaccessible circular radiator *without knowing its size or distance*. The method of measuring temperature which we are going to consider, depending solely on the correctness of the paradoxical proposition just stated, it will be necessary to subject the latter to some test of a practical nature before we proceed to examine, in detail, the device by which the radiant intensity transmitted by a flame, is rendered subservient in determining its temperature. It will be seen by referring to the description of the solar pyrometer, contained in the article before referred to, that the radiant heat transmitted from a circular radiator of known size, to the bulb of a thermometer applied at a known distance, within a vacuum, has been ascertained with critical nicety. It has been shown that, with an angle of 16° 8′ subtended by the axis of the radiator and the heat rays projected from the circumference towards the bulb, the temperature of the radiator will be 12.91 times that indicated by the thermometer receiving the radiant heat. This fixed relation between the angle subtended and the temperature transmitted, is evidently of the utmost importance. In connexion with the fact already noticed, that the intensities of radiators of different size are inversely as the squares of the sines of the subtended angles, it enables us to apply the proposed practical test in support of the assertion that the temperature of an inaccessible radiator may be determined without ascertaining its size or distance. Astronomy furnishes the information that the angle subtended by a line drawn from the circumference of the sun and a line drawn from its centre towards the earth when the latter is in aphelion is very nearly 15′ 46″. The corresponding angle subtended by the radiator of the solar pyrometer and its axis being 16° 8′, it will be found by an easy calculation that the square of the sine of the angle subtended by the sun, is to the square of the corresponding sine of the radiator of the pyrometer as 1 : 3685.71. The experiments with this instrument having established the fact before stated that the intensity of the radiating surface is 12.91 times greater than the temperature transmitted to the focal thermometer, it will be readily perceived that in order to raise the focal temperature to 84.84°, the temperature of the radiator must be 84.84×

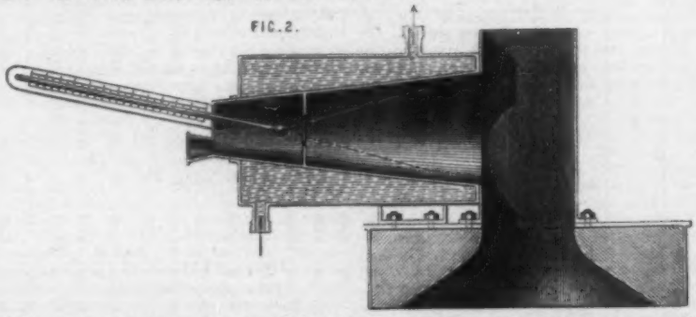


FIG. 2.

12.91=1095.28°. And if we suppose its diameter to be reduced to such an extent that it subtends an angle of only 15′ 46″, like that subtended by the sun, it will be obvious that its temperature, owing to the small radiating surface, must be vastly increased to transmit a temperature of 84.84° to the focal thermometer. The foregoing explanation having demonstrated that the increase of temperature required under the stated conditions, will be inversely as the sines of the subtended angles, viz., 3685.71 : 1, it will be seen that the temperature of the diminished radiator must be 3685.71×1095.28°=4,036,884° in order to transmit the stated temperature of 84.84° to the focal thermometer. It scarcely needs explanation that the temperature last mentioned has been selected as a basis of our calculations on the ground that the intensity of solar radiation is 84.84° at the boundary of the atmosphere when the earth is in aphelion, in which position, it will be recollected, the before mentioned angle—15′ 46″—is subtended. Consequently, the temperature of the sun, deduced from the data furnished by the results of the experiments with the solar pyrometer, without reference to the sun's distance or size, will be 4,036,884°. Now, computations based on the sun's distance and diameter, in accordance with the theory that the temperature produced by radiant heat is inversely as the areas over which the rays are dispersed, in connexion with the ascertained intensity of solar radiation at the boundary of the terrestrial atmosphere, show that the temperature of the sun at the surface of the photosphere somewhat exceeds 4,035,500°. (See demonstration published in ENGINEERING, December 30, 1870). Considering this close agreement between the results arrived at by methods totally different, and considering the severity of the test applied, that of comparing the effect of radiant heat at a distance of 18 in. to that acting through a space exceeding 90,000,000 miles, we cannot question the soundness of the doctrine enunciated at the commencement of our discourse, nor question the practicability of measuring the temperatures of distant inaccessible bodies without knowing their size or distance. The important fact should not be overlooked that our demonstration relates only to the temperature of *circular* radiators. But it will be shown hereafter that the temperature of radiators of an irregular form, whether consisting of incandescent metallic bodies or flames, may also be ascertained, irrespective of the distance and size of the radiating surface, provided that distance be short.

Before examining the adopted expedients of measuring the temperature transmitted by the radiation of flames, it will be necessary to consider their composition. Professor Draper, who has closely investigated the subject, states that the flame of a lamp consists of three principal divisions. First. A central nucleus which is not luminous, and consists of combustible vapour. Secondly. An intermediate portion, the true flame, arising from the reaction of the air and the combustible vapour, and being composed of a succession of superposed shells, the interior being red, the exterior violet, and the intervening ones coloured in the proper order of refrangibility; the cause of this difference of colour being the declining activity with which the combustion goes on deeper and deeper in the flame. As to temperature, Professor Draper considers that the inner red shell cannot be less than 977° Fahr., and the exterior violet one probably more than 2500° Fahr. Thirdly. An envelope consisting of the products of combustion, exterior to the true flame, shining simply as an incandescent body, and its light for the most part overpowered by the brighter portion within. Apart from the difficulty of giving to such a flame as the one described, the form necessary to render exact measurement of its radiant power possible, the result would be of little value owing to the want of homogeneity and uniformity of temperature. Our investigation, therefore, will be confined to what may be termed solid flames of uniform temperature throughout the mass, such, for instance, as the flames of reverberatory furnaces and cupolas surrounded by walls that prevent the action of the exterior atmosphere. Evidently, if we can ascertain what intensity of flame is indispensable to fuse a metal, we at the same time ascertain the temperature of the fused metal itself. It will be reserved for a future occasion, to present a delineation and description of an instrument by means of which the temperature of such flames may be measured for practical purposes; our present object is simply that of answering the theoretical question, is the temperature transmitted by solid flames equal to, or less, than that transmitted by incandescent metallic bodies? The reader will bear in mind that this investigation was originally undertaken to refute the assertion of certain savans that, the temperature of the sun cannot be ascertained because the radiant power of incandescent gases is less than that of incandescent solid matter.

RAIL STRAIGHTENING MACHINE.

CONSTRUCTED BY MESSRS. FRANCIS BERRY AND SONS, ENGINEERS, SOWERBY BRIDGE.

(*For Description, see Page* 355.)

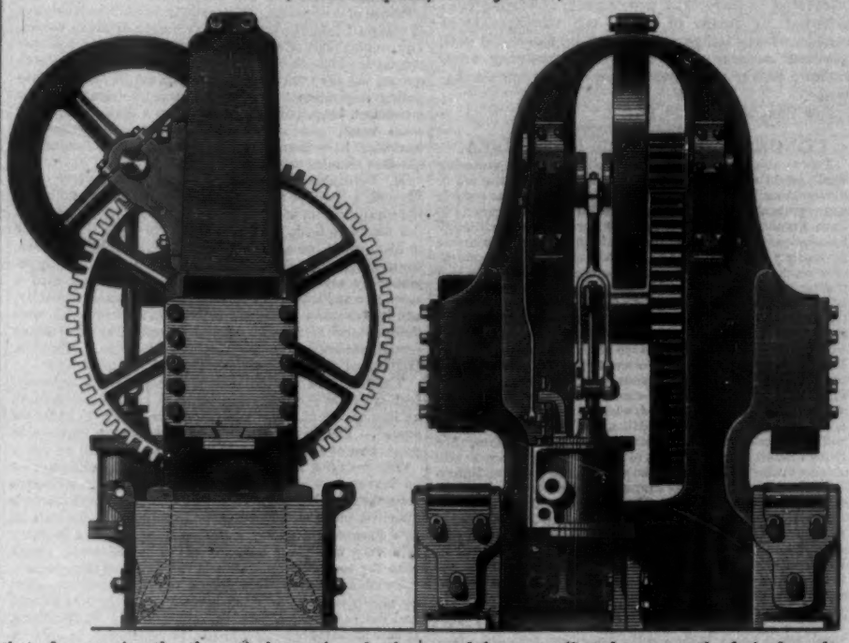


Fig. 1 on the opposite page represents a conical furnace provided with a grate applied at the contracted lower portion, admitting of a free passage of the air over the entire surface. A capacious chamber is formed under the grate, into which air is forced by an ordinary Sturtivant centrifugal blower. The internal portion of the furnace is contracted towards the top as shown in Fig. 2, terminating with a square opening over which is placed a square trunk corresponding exactly with the said opening. The furnace being charged with combustibles that readily ignite, it will be evident that a moderate speed of the blower will, soon after ignition, fill the square trunk with a solid flame of perfectly uniform temperature throughout, contact with the exterior atmosphere being wholly prevented, while the air which supports the combustion is subdivided almost infinitely, and uniformly dispersed, through the mass of burning fuel. A chimney of very large section, equal to that of the contracted part of the furnace, being applied above the square trunk, any tendency to pressure and accumulation in the same will be effectually prevented. A solid flame of uniform temperature having thus been obtained, its radiant power has been ascertained by the following device. A conical vessel open at the large end, surrounded with a water jacket of cylindrical form, shown in Fig. 2, page 350, is secured to the square trunk, a circular opening being formed in the side of the latter, corresponding with the open end of the conical vessel. Referring to Fig. 2, it will be seen that a perforated diaphragm (composed of polished silver) is introduced near the small end of the conical vessel. A thermometer is applied near the circular perforation of the diaphragm, the bulb being placed exactly in the centre line of the vessel. An opening, surrounded with a short conical tube, covered with a piece of mica, affords a view of the interior of the conical vessel. The water jacket is supplied from the street main, a constant stream being kept up during experiments. The application of a chimney of large diameter above the square flame-trunk, and the covering the short conical tube with mica, as stated, in order to prevent any current of heated air or gas through the conical vessel, have contributed to secure the desired result. A disc of flame of uniform brightness, the colour varying with the speed of the blower, has been successfully produced. Respecting the experiments which have been instituted, it may be briefly stated that, when the blower is worked at the most advantageous speed for producing a flame of maximum brightness, the thermometer exposed to its radiant heat indicates 282°, while the temperature of the water circulating through the external casing is 73°. Hence, the heat transmitted to the enclosed thermometer by the radiation of the flame, produces an augmentation of temperature of 282—73=209° Fahr. The angle subtended by the centre line of the conical vessel and lines drawn from the circumference of the flame-disc to the bulb of the thermometer, being 16° 8′, precisely as in the solar pyrometer, we know that its temperature must be 12.91 times greater than that indicated by the enclosed thermometer. Accordingly, the temperature of the flame passing from the furnace through the quare trunk into the chimney will be 12.91×209= 2698° Fahr., a result corresponding very nearly with ordinary pyrometer indications; a fact, however, of little importance in view of the uncertainty of such indications. It will be supposed that the stated high temperature of the flame must at once destroy the square trunk. Such, however, is not the case, from the reason that the trunk is made of plate-iron only $\frac{1}{16}$ in. thick, the radiation of which is so rapid that the gases composing the flame—(these gases being slow conductors)—cannot communicate the heat as fast as it is carried off by radiation. The top of the furnace at the point where the flame is concentrated and conducted into the square trunk, being exposed to intense heat, is lined with fire clay. It should be observed that the apparatus is exposed to a high temperature only while the blower is in operation, the motion being stopped as soon as the internal thermometer reaches maximum indication.

It will be noticed by those who have attentively studied the article on radiant heat published in ENGINEERING, November 25, 1870, that unless the radiant surface forms a spherical concavity, the focus of which coincides with the centre of the bulb of the recording thermometer, the indication will not be exact. The flame-disc being *circular*, this objection is overcome by removing the thermometer from the face of the flame to such a distance that the mean length of the heat rays transmitted to the bulb corresponds with the radius of a concave radiator of the same diameter as the flame-disc, subtending the before-named angle of 16° 8′. As already

mentioned the consideration of *the practical application* of the principle developed by the apparatus represented by our illustration, almost self-evident to constructive minds, has been reserved for another occasion. In the meantime engineers will be interested to learn that instruments are being constructed by means of which the temperature of metals, of any temperature, may be measured with positive accuracy by simply ascertaining their radiant power at a convenient but unknown distance.

New York, November 10, 1871.

CONCRETE WHARF AT BATTERSEA.

The remains of many ancient buildings and engineering works afford ample evidence of the antiquity of the art of constructing in concrete. This practice, however, as regards superstructures appears to have fallen into disuse, and to have been again revived in very recent times, although foundations and substructures have been executed in concrete for many years past. We have lately examined an example of concrete work as applied to the construction of a wharf wall and basement story of a warehouse on the bank of the River Thames at Battersea. So far as we are aware this is the first application of the system to works of this class in the present day, and it has been effected by Mr. R. M. Ordish, who was applied to for a design for a river wharf at the Patent Plumbago Crucible Works, Battersea. He decided on adopting the built-up concrete system partly from experimental knowledge of the qualities of concrete when properly mixed, and also from having observed, when in Algeria, the remains of a barrage across the river Mina. Although this barrage was constructed by the Romans many centuries since, Mr. Ordish found that the marks of the mould-boards were still clearly visible on the face of the work. The wharf at Battersea belongs to the Patent Plumbago Crucible Company, the makers of Morgans' Patent Crucibles, and is an extension of the river frontage of their premises on to the foreshore of the river. The wharf is about 60 ft. square in plan and consists of a storage vault and a building of three stories, which has been carried up in brick and iron above it. The floor of the concrete wharf is at the level of Trinity high water, the floor of the vault being 10 ft. below it. The foreshore of the river was excavated to the hard gravel upon which a bed of cement concrete 2 ft. in thickness was laid. The roof of the vault, which forms the floor of the lower part of the superstructure, is also of cement concrete, and is carried on twenty-four brick piers. The vault roof is groined, and at the crowns the concrete is 1 ft. thick. Openings have been left in this roof for communication with the wharf floor above, and are closed with wrought-iron flap-doors hinged to cast-iron frames. The floorings of the vault and of the ground floor of the wharf are both paved with 2½ in. York stone.

The concrete walls are 3 ft. 6 in. thick at the base, and 2 ft. 9 in. at the top, the front wall having been carried 15 ft. below Trinity high water mark, and all the walls terminating 3 ft. 3 in. above that level. Ordinary fender piles, provided with mooring rings, are held by 1½ in. anchor bolts, 6 ft. long, and which are built into the front and side walls of the structure. In constructing the wharf, the foreshore was first excavated, about 2000 tons of stuff being removed. Fender piles were then driven, and afterwards a row of piles on the inside of the site of the proposed walls. Mould boards were then fixed horizontally against the piles, and the concrete was tipped in from staging. As the works were submerged when the tide rose, the construction could only be carried on between tides. As the work advanced additional mould boards were placed in position, and were removed as the structure progressed and the concrete set; in this way the walls were raised to their proper level. The concrete consisted of 1 part Portland cement to 4 parts Thames ballast and sand, and about 1000 cubic yards were used in the structure. The cost of this portion of the work was about 2000*l*., showing a saving of something like 25 per cent. in cost as against brickwork.

As the first of its kind in modern times, this structure may be regarded somewhat in the light of an experiment, although a successful one. We visited the works both during their construction and after their completion, and found at the finish that though there were indications of moisture coming through one of the side walls, it could hardly be termed a leak. An examination of these damp spots, where the concrete had been cut out, showed that they were caused by unavoidable accident in mixing the material, some small portions of the concrete not having had sufficient sand and small materials mixed with the ballast. The concrete being somewhat coarse at these points, permitted a slight percolation of moisture, which, however, was readily stopped by cutting out the defective portion, and filling in the space with cement. This wharf may therefore be considered a success, and will doubtless lead to the adoption of the built-up concrete system in future structures of similar character, combining, as it does, strength and economy.

The upper portion of the wharf is carried to a height of 33 ft. above the coping of the concrete walls. The side walls are of brick, the front being of brick and iron combined. Cast-iron columns carry breastsummers of the same material, the openings being filled in with brickwork and glass. The front is surmounted by a brick cornice, and presents a light and ornamental appearance. The floors are supported on internal cast-iron columns, and the roof is of timber, and is covered with a superior quality of slating procured from the Moelfre slate quarry near Port Madoc. The lower portion of the front of the original building, against which the new superstructure abuts, was removed to a height of 18 ft. for the whole width, in order to form an opening for connecting the new building. This opening left about 18 ft. of brickwork, above which, of course, was underpinned. The contract for the superstructure of this wharf was taken by Messrs. Manley and Rogers, the cost being about 3000*l*., making a total for the whole work of 5000*l*.

NOTES FROM PARIS.

Paris, Nov. 27, 1871.

Protection of Workmen.

The Société d'Encouragement was occupied during its last sitting with a discussion upon the means of obtaining by ventilation a protection for workmen from the pernicious influence of dust passing from grindstones. The inhalation of this dust into the lungs results yearly in many deaths. The employment of a small protecting apparatus has been proposed, which should arrest the particles upon a damp sponge, but the workmen object to the use of anything impeding respiration. Besides the dangers from the cause mentioned, large grindstones, driven at a high speed, sometimes burst, and although many ingenious methods of mounting have been devised to prevent this danger, the question remains unsettled.

M. Goldenberg, chief of a large manufactory near Saverne, submitted to the society an interesting notice on the arrangements adopted in his grinding shops, to protect the workmen from the dangers always to be apprehended in using grindstones. To prevent the rupture of the stones, the use of wood is discarded in the mounting, and it is replaced by cast-iron plates. The stone is tested with a speed one and a half times as great as the ordinary velocity, and it is examined carefully before and after the trial, with the assistance of the workman who attends to it, and whose special interest is to see that it is in a good condition. High speed motors are preferred for driving the stones.

The process of ventilation is perfectly rational and satisfactory. The speed of the air driven around the stone, in an iron sheath that surrounds it, varies from 6 to 13 ft. per second. The sheath can be reduced in size as required, in proportion as the diameter of the stone is lessened by use.

The Société d'Encouragement have also offered a prize for an invention which shall protect the cutters of millstones from the dust. It is at La Ferté-sous-Jouarre that the stone is quarried, and the millstones prepared, which are sent all over France, and exported widely abroad. The industry is a very important one, and the manufacturers, struck with the mortality that attends the workmen they employ, subscribed a sum of 5000 francs towards the prize. But no satisfactory and working invention has yet been offered, and the commission, with the assistance of M. Catelliers, is now undertaking experiments, in ventilation, in order to ascertain what useful results can be achieved by it, to prevent the injurious action of the dust.

The current of air was produced by the help of a fire and uptake; three vertical mouths were opened for three workmen occupied in the cutting of the stone, and two others for workmen engaged in dressing it. These mouths were surmounted with apparatus in plate iron intended to collect the dust in every position that the workman is obliged to assume during his labours.

Having given to the air in the dressing shop a speed of about 10 ft. per second, it was found that this method was very useful in carrying away the dust, the damped sponge arrangement collecting only half as much dust as the blast in a given time. The influence of the system is especially remarkable, when, by the aid of screens, the current is concentrated on the part of the stone struck by the tool. There is perhaps in these first trials a point of departure for a useful reform. There remain, however, many practical difficulties to render the process generally useful.

Boiler Explosions in France.

The number of boiler explosions in France during the year 1869 form a total of 18 accidents, which have caused the death of 22 persons, and occasioned injuries to 20 others. These accidents are divided as follows, according to the establishments in which they occurred:

Iron works	1
Steam boats	2
Railways	1
Cotton factories	2
Sugar works	1
Various	11
	18

According to the class of apparatus the accidents are divided thus:

Horizontal cylindrical boilers with or without tubes	6
Horizontal cylindrical boilers with internal firebox	1
Tubular boilers, including one locomotive	6
Cylindrical vertical boilers	2
Steam recipients	3
	18

The causes which occasioned these explosions were as follows:

Imprudence or negligence of proprietors or tenders	12
Bad construction	3
Accidental causes	2
Unknown causes	1
	18

It is interesting to compare these results with the statistics of boiler explosions in England, where every advantage is to be found for obtaining good material, workmanship, and skill in manufacturing and tending. The reason of the striking contrast is to be found in the fact that here there exists an efficient system of inspection—a thing very partially known in England. Much serious action has been taken there to obtain an improved condition of things, but public opinion appears averse to Government interference. How well it works in this country is evidenced by the figures given above, and there exists no serious hindrance to the progress of boiler construction or interference to boiler users dreaded so much in England. Experience shows that no other system will be efficacious, and unless private prejudices are of more importance than the lives annually sacrificed in boiler explosions, the system of Government inspection will be established in England as it has been established here.

Domestic Steam Engines.

MM. Mignon and Rouart, mechanical engineers of Paris, are supplying, upon the system of M. Fontaine, a small domestic steam motor, of which the former varies from one to four-fifteenths of a horse power. This class of machine can be employed for driving a lathe, a pump, a ventilator, a circular saw, a sewing machine, jewellers' and polishers' tools, and, in fact, all machines now driven by hand or foot power. Their use would improve the condition of the workmen, saving them from fatigue, and from the necessity of employing subordinate labour, and it would at the same time increase their producing power. If the employment of these little machines becomes general, it will affect considerably many large industries by enabling the workmen to labour at home at a variety of employments which to-day are carried on in large shops.

The following are the details worked out by MM. Mignon and Rouart. The machine is a steam engine heated by gas. The burners are of the Bunsen type. The boiler is tubular and vertical, with a gas jet for each tube. The fire space, after passing around the steam chamber for the purpose of reheating it, is connected at the bottom of the machine with the chimney of the room in the same manner as a stove. One of the difficulties to be overcome was in feeding the boiler. The inventors have provided against this by simply making the boiler large enough to hold a supply of water ample for several hours, so that it is sufficient to fill the boiler once or twice a day. The capacity of the boiler is 4 gallons, two-thirds of the space being used for water, and the rest for steam. To prevent any trouble in regulating the gas flames, a special arrangement is adapted to proportion the consumption of gas to that of the steam, and to the loss of heat by radiation. When the engine is at rest the flames are reduced so much that only sufficient gas is burnt to maintain the steam at a given pressure. When the engine is at work the flames increase, combustion becomes more intense, and produces all the heat necessary for the formation of steam consumed by the engine. This is effected by a folded tube, which varies in height according to the pressure of the steam in which it is placed, and the movements of which are transmitted to the gas cock. Thus this device at the same time becomes a safety valve.

The engine is of a very simple form. The frame, the cylinder, the valve chamber, the guides, and the bearings are of a single piece of cast iron. In the same way the shaft, the hand lever, the eccentric are in one piece.

Such a machine weighs about 2 cwt., and costs 500 francs; it has only 33 in. height, and can be used in any chamber without difficulty or danger.

MACHINE FOR FLANGING BOILER PLATES.

To the Editor of Engineering.

Sir,—Mr. Adamson has paid to me royalty or patent right upon the very machine you have illustrated and given publicity to as being his design and patent. This is an answer to the attempt to take away my rights.

I am a widow with five children, and am sole executrix under my late husband's will, who was inventor and patentee of this machine; one of which has been at work at Mr. Beeley's Hyde Junction Iron Works, near Manchester, for nearly two years, and was fully described and illustrated in *The Engineer* of March 17th, 1871, page 178, to which your readers may refer.

My husband met his death a few weeks since by an accident at the above works, and as these patents form the "staff" upon which my family and I depend, and Mr. Adamson knows this, I ask you to give this letter as much publicity as the article referred to above, and in as conspicuous a place in your journal. You may be sure the article in question has occasioned me much pain, as neither the design nor the development of the patent belong to nor emanated from Mr. Adamson.

Yours respectfully,
E. Hanson.

Dukinfield, near Manchester, November 30, 1871.

[It may be satisfactory to Mrs. Hanson to know that Mr. Adamson is in no way responsible for the publication of the engravings given by us last week.—Ed. E.]

To the Editor of Engineering.

Sir,—We notice in Engineering of last week you illustrate and describe machinery for flanging boiler plates, as being designed and lately patented by Mr. Daniel Adamson of Newton Moor near Manchester. We beg to state the machine was designed and manufactured by us under "Hanson's Patent" and sold as such to Mr. Adamson; we have made several and are the sole manufacturers.

We are sorry thus to trouble you, but in justice to the wife and young family of the late Mr. Hanson who are not well provided for, we reluctantly take up the subject on their behalf.

The deceased Mr. Hanson was foreman boiler-maker for Mr. Beeley, of Hyde Junction Iron Works, Hyde; where he unfortunately met with a fatal accident some few weeks ago, while in the discharge of his duties.

I remain yours truly,
Manchester, Nov. 29, 1871. William Muir and Co.

STEAM COEFFICIENTS.

TO THE EDITOR OF ENGINEERING.

SIR,—I have just now received yesterday's ENGINEERING, and have read Mr. Smith's letter, and at once forward the following reply.

Mr. Smith says: "It is just on this point that the whole question of the value of these coefficients rests, and it is just here where Mr. Gray makes his grand blunder. Thus in finding a coefficient by the latter formula to compare with the coefficient given with the diagrams he still virtually divides by the terminal pressure 6.125, i.e., the terminal pressure due to a perfect gas instead of by the terminal pressure due to the expansion law assumed. It is obvious that such a comparison is absurd. His rule for the coefficient being this: 'Divide nine by the ninth root of the ratio of volumes, and deduct the quotient from nine also,' when the rule should be: Multiply ten by the ninth root of the ratio of volumes, and deduct ten from the product. This rule will give Mr. Gray a coefficient that he can directly compare with the one given with the diagrams, and yet be a coefficient under mathematical conditions from which he can always deduce, if so minded, the value of the steam before it had parted with any of its energy.

"In the case in point Mr. Gray's formula for the total gross coefficient is this,

$$\text{Gross coefficient } 3.2355 = 1 + \text{hyp. log. } 1.882 + 9 - \frac{9}{5.845^{\frac{1}{9}}}$$

When it should be,

$$\text{Gross coefficient} = 1 + \text{hyp. log. } 1.882 + (10 \times 5.845^{\frac{1}{9}}) - 10.$$

Working out the latter formula we have:

Log. $5.845^{\frac{1}{9}}$	=9)	.706785
		.085198
Log. 10	=	1.000000
Log. 12.167	=	1.085198 = log. $(10 \times 5.845^{\frac{1}{9}})$
10		
2.167	=	$(10 \times 5.845^{\frac{1}{9}}) - 10$
.6323	=	hyp. log. 1.882
1.	=	effect of admission

3.7993 gross coefficient.

This is the theoretical coefficient due to the law under which the steam expanded. To prove that it is correct, and that Mr. Gray did virtually divide by 6.125 instead of 5.0837—which was the terminal pressure he found due to that law of expansion—let us take the coefficient he obtained, and inverse the proportion; thus $\frac{(1.0632+1)\times 6.125}{5.0837} = 2.167$. Deducting 1 from this for the effect of admission, we have 2.167, or exactly what is obtained for this part of the expansion from the preceding formula as worked out."

Let this extract as "the whole question" and as my "grand blunder" be submitted to an university professor of mathematics or of engineering (say to Professor Rankine). If the referee decide that Mr. Smith's formula is right, I will send for publication in your journal a retraction of all my letters, and a sum of five pounds to be given to any charitable institution the umpire may elect. This offer is contingent on Mr. Smith's agreeing to the same terms on his part, viz., should the decision be that my formula is correct, that he will publish in your journal a withdrawal of his letters and pay five pounds as above.

I forward this by first post after receiving the paper to leave you ample time to communicate with Mr. Smith, and to give his reply with this in your next issue. I need not say that neither of us should be allowed to communicate direct with the referee, only through your journal.

I am, Sir, your most obedient Servant,
J. MCFARLANE GRAY.

12, Montenotte, Cork, Saturday evening, Oct. 28, 1871.

P.S. The word "also" in the above quotation from my letter is an erratum, you will find in my copy the word also belongs to the following sentence. This was one of the errata telegraped to you. Please explain that these errata were not on my copy, they referred to your proof sent to me for correction.—J. MCF. G.

TO THE EDITOR OF ENGINEERING.

SIR,—Haste to catch the post prevented me adding to my last letter all the matter I had prepared bearing on this subject. I now send you what was thus unavoidably left out. Thus after calculating the theoretical coefficient due to expansion by the $\frac{1}{9}$th root formula as I do near the end of my letter (page 338) getting 3.75 coefficient, I intended to add that this 3.75 is the measure of the largest cost that can possibly be made out of a given piece of cloth on this system of cutting.

In dealing with this part of the question Mr. Gray says he gives me my "own way." He only says he gives me my own way however; he does not really do it. He does not, nor cannot, challenge the truth of the logic in my letter of 13th October with reference to taking the "lower pressure as a measure for the standard of perfection, and if he gives me my own way he allows me to use this *lower pressure*—that is, the pressure without the 16.17 per cent. of scrapmis this case a pressure of 5.272 lb., and to show that this is virtually my divisor, and that 6.125 is still Mr. Gray's, take the gross theoretical coefficient obtained by him, viz., 3.227, and invert the proportion as before $\frac{3.227\times 6.125}{5.272} = 3.75$, or exactly the coefficient as obtained by the formula given, viz., coefficient $3.75 = (17\times 11^{\frac{1}{9}}) - 16$.

If further testimony be wanting as to the value of taking the actual terminal pressure in the cylinder as a criterion of the comparative efficiency of engines, I would refer to the valuable experiments of Professor Bauschinger just published in your journal, more particularly to the Tables Nos. 7 and 8 in your issues of October 20th and November 17th respectively. Column P of Table 8 contains coefficients of efficiency deduced from the actual terminal pressures in the cylinders, and immediately below this column it is stated that "the results in column P should be taken as a criterion by which to judge the action per pound of steam."

With reference to Mr. Gray's statement that, "if we have a coefficient of 3 that reads that there was given out as available power by the steam not more than three-tenths, or .3 of the power or energy originally stored in it." Now Mr. Gray has no need to assume that a coefficient 3 means anything so meaningless, for when the coefficients were given with the diagrams you them distinctly stated that these coefficients were obtained by using the actual terminal pressure in the cylinder as the factor, and this was of course measuring the steam after it had parted with the energy corresponding with the work performed; so that the coefficients given had reference to a certain positive value to the steam in the latter condition, and it is just from coefficients so derived that approximate positive values for good and bad engines are obtained. If such coefficients are not legitimate, neither are the same coefficients, although given in another form in Professor Bauschinger's Tables legitimate, and that being the case we may bid adieu to the hope of getting at the approximate comparative efficiency of different engines by any treatment of indicator diagrams.

I have now to acknowledge receipt of a copy of a letter submitting a proposal from Mr. Gray for the ultimate disposal of this question. Now, as Mr. Gray has taken the liberty of proposing to narrow so much the settlement of "the whole question," I will take the liberty of narrowing it a little further just to simplify the settlement, and then I will with the greatest pleasure accept the mode of settlement proposed. It is the accuracy of my formula that he mainly disputes. It is deduced from Rankine's approximate equations for the non-transmission curve, and, using Rankine's symbols it is this:

$$\frac{P_m}{P_i} = 10\,r^{\frac{1}{9}} - 9,$$

or substituting:

$$\frac{\text{Mean total pressure}}{\text{Final pressure}} = (10\times 5.845^{\frac{1}{9}}) - 9 = 3.167.$$

This is my formula, pure and simple. If the referee decide that it is correct, Mr. Gray will send for publication in your journal a retraction of all his letters, and a sum of five pounds to be given to any charitable institution the umpire may elect; should the decision be that the formula is wrong, then I will retract my letters and pay five pounds as above.

And let me here mention to Mr. Gray that I perfectly understand the meaning of Rankine's ratio, $\frac{r\,P_m}{P_i}$, and will take good care that it does not get muddled up with quite another ratio.

If Mr. Gray will not accept a settlement of "the whole question" by a limitation to the accuracy of the formula given above, then the question cannot be settled in this way, for the extract from my letter that Mr. Gray submits does not contain all the qualifications that give that extract its real meaning. And as the whole truth is better than only part of the truth, the whole question should therefore be considered on its real merits, and not disposed of by an undignified resort to a mere betting transaction such as has been proposed.

Yours respectfully,
CHAS. SMITH.

Hartlepool Iron Works, November 29, 1871.

[We shall probably comment on this correspondence next week.—ED. E.]

"A STEAM ENGINE TRIAL."

TO THE EDITOR OF ENGINEERING.

SIR,—My letter in ENGINEERING of 17th inst. was written in no captious spirit. I wanted to learn how it was that the engine at Hele, of which the account is so favourable in other respects, showed such a great variation of speed when at work. This information is still required. It is known and admitted that there are considerable variations of strain upon any prime mover that drives rag engines, but in the case before us, the report states that throughout the day every endeavour was made to keep the work to be done as constant as possible, by charging the rag engines in succession. Therefore, had it been a day of ordinary work instead of a testing day, the variations of strain would have been more, leading to the inference that the variations of the engine's speed would have been greater. Can one learn what the fixed and standard speed of the engine was intended to be, and why it deviated so much from that speed? Does the phrase, "the engine was simply driven at different speeds" mean that the variations were intentional, and caused by the engineman on purpose? or is the engine not possessed within itself of arrangements for regulating its speed, say within one revolution per minute, even with a varying load, to drive which it seems to have been expressly constructed?

Yours truly,
November 28, 1871. INVESTIGATOR.

[We believed that our note appended to "Investigator's" former letter clearly expressed that the engine at Hele was intentionally driven faster during the main part of the trial than during the first two hours. The efficiency of the governor was not submitted to any formal test, and we cannot therefore answer "Investigator's" last question. In any case the efficiency of the governor had nothing to do with the efficiency of the engine as a steam user.—ED. E.]

MR. BATEMAN AT BUENOS AYRES.—A commission has been appointed by the Provincial Government of Buenos Ayres to inspect the port with the view of carrying Mr. Bateman's plans into practical effect.

MR. MALLET'S CIRCULAR.

TO THE EDITOR OF ENGINEERING.

SIR,—It does not require my pen to defend Mr. Mallet. He is well able to answer for himself, but surely it would be well for "A Member of the Institution of Civil Engineers" who writes in yours of 24th inst. to read and judge more carefully in future. He would not then, it is to be hoped, hastily and unjustly hold up any one to general censure or make the palpable error he has done. Mr. Robert Mallet being a Past President of the Institution of Civil Engineers *in Ireland*, has a perfect right to mention the fact. He did not state or imply that he had been President of any other Institution of Engineers. It will now be for the public to judge of the "good taste" or the animus of your correspondent in publishing the business circular of a professional man, as he has done, and in his making a groundless and ridiculous insinuation against an honourable member of the profession.

I am, Sir, yours faithfully,
A MEMBER OF THE INSTITUTION OF CIVIL ENGINEERS AND A FORMER MEMBER OF THAT INSTITUTION IN IRELAND.

November 27, 1871.

TO THE EDITOR OF ENGINEERING.

SIR,—My attention has just been called to an anonymous letter in your impression of this day's date, in which I am charged by the writer with having affirmed in a lithographed circular, which you have printed, that I have been President of the Institution of Civil Engineers (i.e. of London), of which the writer signs himself a member.

I have not made any such statement, nor intended to convey anything so contrary to fact. What I have stated, as any one can see who reads the passage fairly, and as you have printed it is, that I am a Member of the Institution of Civil Engineers, Past President of that body *and* of the Royal Geological Society *in Ireland*, all of which is perfectly true. I have italicised the words which indicate the true and obvious rendering of the sentence which would have been still more obvious but for the omission of a comma in the lithograph. As to the taste, good or bad, of the circular, or the animus of your correspondent, I am not called upon to discuss them in your columns, in which I expect in justice you will insert this in your next impression.

Sir, your obedient Servant,
ROBERT MALLET.

7, Westminster-chambers, Victoria-street, London,
November 24, 1871.

[We most willingly publish Mr. Mallet's explanation of what he intended to express, but nevertheless the passage "Member of the Institution of Civil Engineers, Past President of that Institution and of the Royal Geological Society in Ireland," can grammatically bear but one interpretation, namely, that given to it by our correspondent last week, and by the many others who have written to us enclosing copies of the circular. Even the italics which Mr. Mallet has introduced, do not alter this. We may point out also that Mr. Mallet has in the letter we now publish substituted the word "body" for "Institution," a material alteration. We may also remark that the Institution of Civil Engineers in Ireland is an entirely independent body, having no connexion in any way with *the* Institution of Civil Engineers.—ED. E.]

VALVES FOR BLOWING ENGINES.

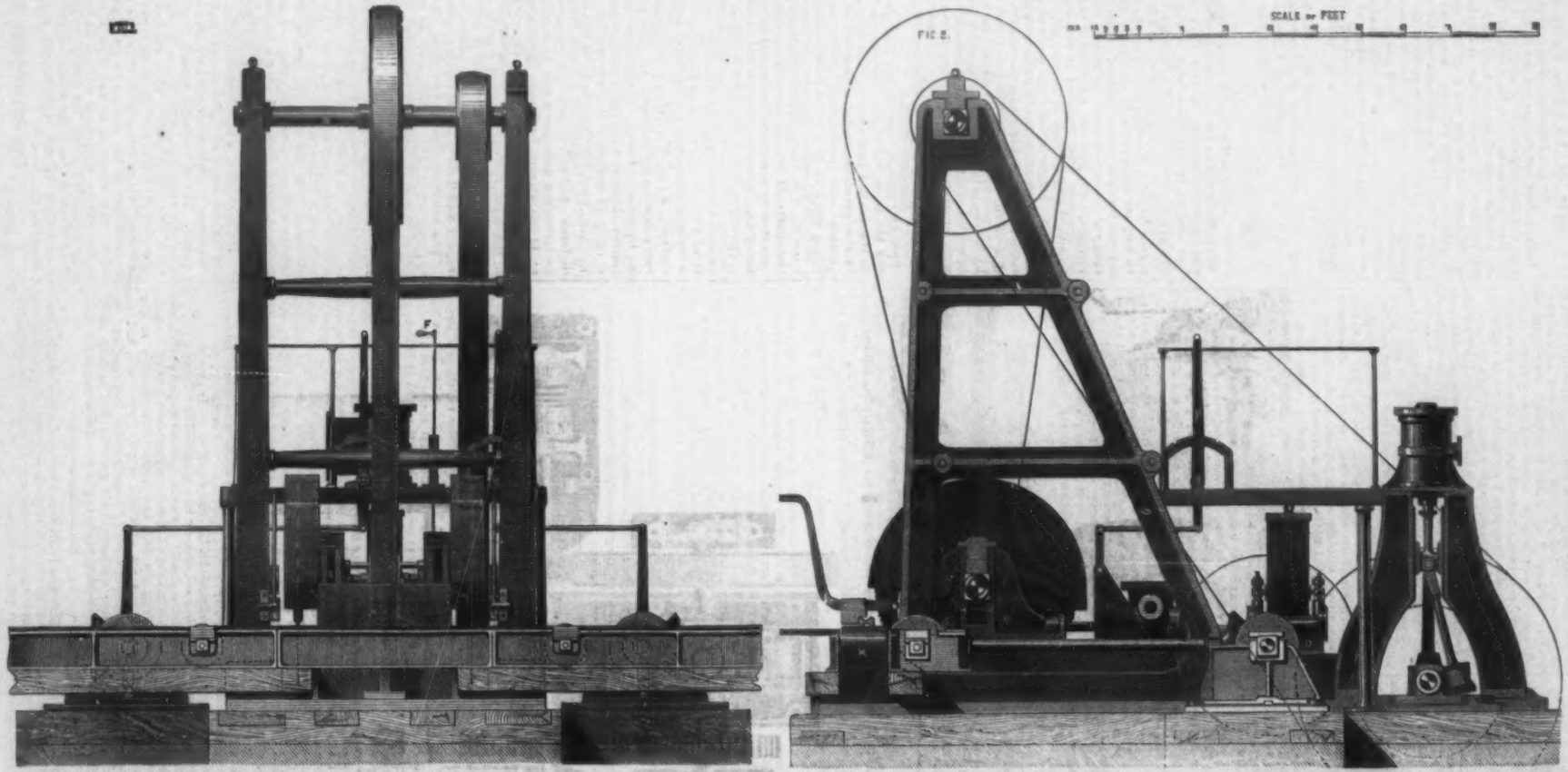
TO THE EDITOR OF ENGINEERING.

SIR,—In your last impression you illustrate and describe an arrangement of blowing cylinder air valves, the invention of Messrs. Hargreaves and Inglis, and you mention that you also desire information as to their practical working. The only place that I am aware of, where they have been tried, is at the Solway Hematite Iron Works, Maryport, and the result there has been a total and complete failure. The blowing engines there are a pair of coupled direct-acting vertical engines, made by Messrs. Hargreaves and Co., and originally fitted with valves and chests exactly as you have illustrated. The objections found against this arrangement of valves are many; their first cost is great, and the longest time that any one of the valves kept in anything like order, was only a fortnight. The india-rubber kept slipping off the tubes, or got cut in two by striking against the guards, and such a constant leakage took place, that when blowing two furnaces only 2½ lb. of blast could be maintained at a speed of 48 to 50 revolutions per minute of the engines. At this speed the noise in the engine room was such that no one could stay in it. This noise was occasioned by the violent rushing of the air through the small openings, and by the valves dancing on their seats till the succeeding stroke raised them again. In short, the Solway Co. were so much annoyed by the frequent stoppages of the engines to repair the valves, and in consequence of these stoppages, and the low pressure of blast, the utter impossibility of their making Bessemer iron, notwithstanding they had the best of coke and ore to make it from, that after a six months' trial they decided on taking the valves and chests off, and substituting others which would be more durable, and give them a higher and steadier blast at a more moderate speed of the engines. This has now been done, and the result obtained by the new arrangement has been as complete a success as the other was a failure. This arrangement consists of rows of ordinary leather flap valves hung vertically in the chests. The pressure of blast now obtained is 4½ lb. constant, at a speed of the engines of 36 or 37 revolutions per minute; and to show there is no leakage taking place when the connexion to one furnace is shut off, the pressure of the blast instantly rises to 6 lb. This letter is in no way intended to disparage the work of Messrs. Hargreaves and Co., for the workmanship of the engines is first class, but is simply to give your readers correct information as to the working of these patent valves as exemplified in the dearly-bought experience of the Solway Iron Company.

I am, Sir, your obedient Servant,
NOV. 29, 1871. VERITAS.

RAIL SAWING MACHINE AT THE BRITANNIA WORKS, MIDDLESBROUGH.

CONSTRUCTED BY MESSRS. COWANS, SHELDON, AND CO., ENGINEERS, CARLISLE.



COAL DISCOVERY.—An important discovery of coal has been made at Halesowen, a village on the East Worcestershire side of the Black Country, and within a few miles of Birmingham. Mr. J. S. Dawes has been sinking trial shafts and exploring in this neighbourhood for the last seven years, and at length, after an expenditure of 20,000*l.*, his enterprise has been rewarded by the discovery of a seam of coal, 14 ft. thick and of excellent quality. It is believed from the position and general features of the measure that its thickness will be found to increase as the work of excavation progresses. Enough has, however, already been proved to falsify the theories hitherto held as to the boundary of the coal-field in this direction, and the impending exhaustion of the Black Country fuel supply. The coal lies at a depth of about 420 yards, a headway of 1005 yards having been driven from the bottom of one of the trial shafts. Mr. Dawes intends to continue his lateral excavations 1000 yards further, through the property of Lord Lyttelton.

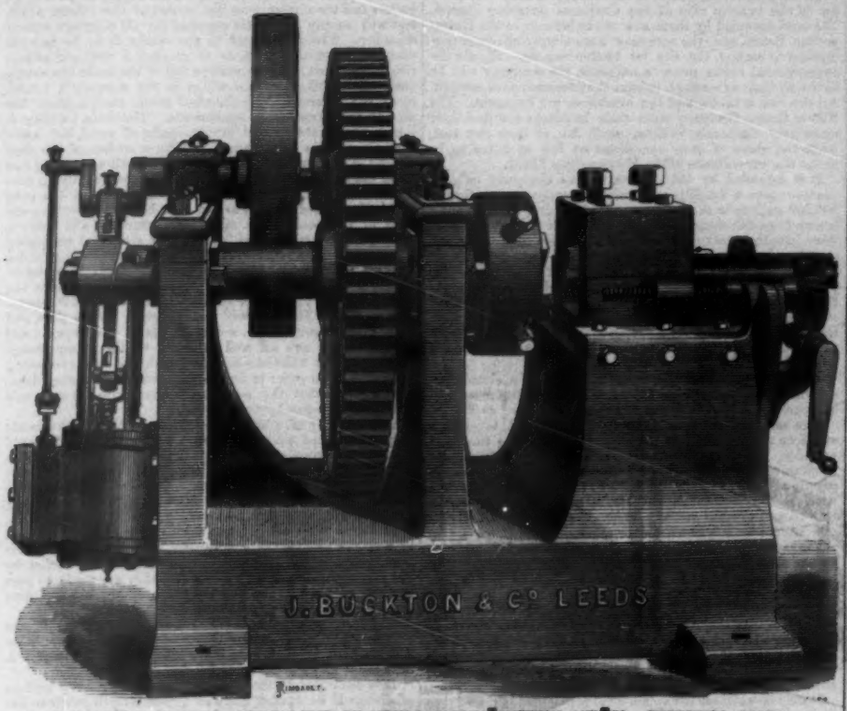
PATENT LAW REFORM.—Under the eccentric title of "Patent Wrinkles," a little book has just been issued to the public. The anonymous author, evidently an unrewarded inventor, deals with the many difficulties he and the generality of his class have to struggle against—costly processes, obstructive legislation, the rocks, and shoals of infringements and dishonest imitations, upon which so many frail crafts of invention are wrecked and stranded. He enlarges on the various classes of individuals who lie in wait to discourage and defraud the patentee, and rob him of his just reward, and he does not forget to allude to those few honest and earnest patrons of ability, whose helping hands have often saved the inventor and benefited the world. Finally he proposes a remedy for the many existing evils, and evidently dreams of an inventors' millennium, when the poor man shall be able to secure his ideas, and have a fair proprietorship in them, as they, assisted by capital, shall be developed into usefulness. The little book we allude to is written in an earnest spirit, and though without any literary merit, deserves attention as being the voice of one of a large body of struggling inventors. Apparently the writer has attempted a fantastic manner in order to attract readers; it is possible by this attempt he may gain a large audience, but not one whose opinions carry with them much weight.

OUR GUNBOATS.—Every effort is being made at Chatham Dockyard to hasten the construction of the fleet of iron gunboats now being built there, and for this object many of the hands are now working upon the vessels overtime, making a day and a quarter per day. The gunboats will be formidable little vessels. There are four of the Kestrel class—the Rifleman, the Ready, the Frolic, and the Kestrel, carrying four guns each; two of the Coquette class—the Aërial and the Zephyr, also carrying four guns each; and two of the Snake class—the Badger and the Fidget, which will be armed with one gun each.

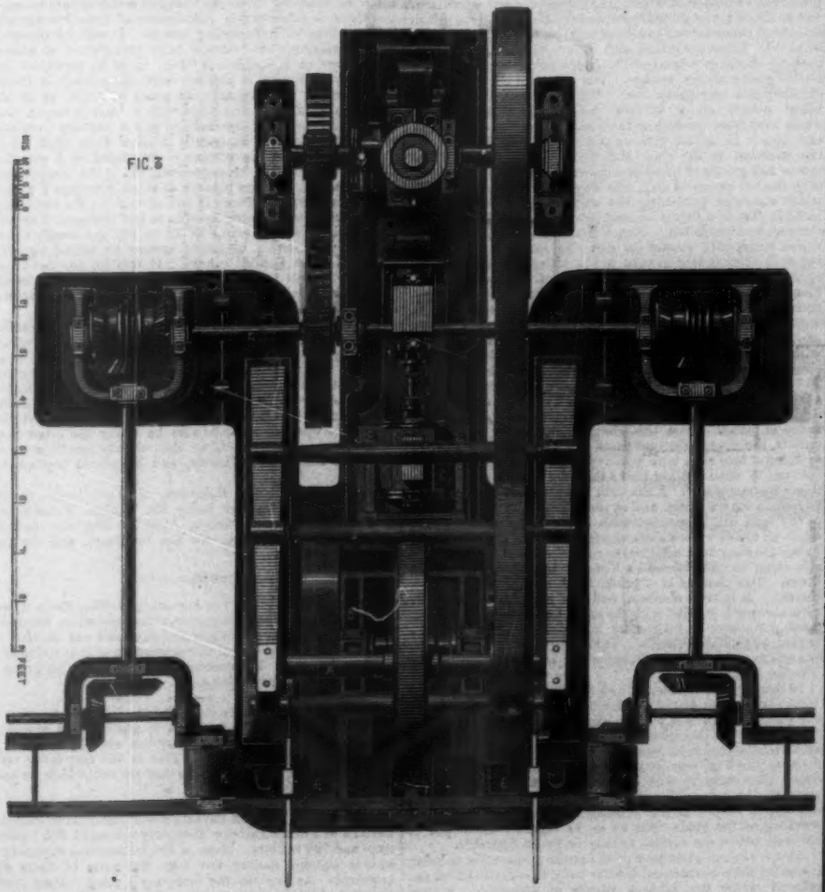
AMERICAN STEAM TONNAGE.—The Register of the United States Treasury states that the steam tonnage of the United States for the year ending June 30, 1871, was 1,087,637 tons, showing an increase during the year of 12,542 tons. Of this considerable steam tonnage, rather less than 50,000 tons is regularly engaged in the foreign trade of the United States.

RUSSIAN SILVER, COPPER, AND LEAD MINES.—Intelligence has reached St. Petersburg from the central Asiatic Province of Semipalatinsk, to the effect that copper mines with more than 60 per cent. of pure metal have been discovered. Silver mines yielding $\frac{1}{4}$th of pure ore, lead mines containing $\frac{3}{4}$ of the metal, and coalfields whose product gives from 60 to 90 per cent. of coke, are likewise included in the treasure trove. The immediate consequence of the discovery will be to send some thousands of Russians to the spot.

MACHINERY AT THE BRITANNIA WORKS, MIDDLESBROUGH.



RAIL-ENDING MACHINE, CONSTRUCTED BY MESSRS. JOSHUA BUCKTON AND CO., ENGINEERS, LEEDS.



PLAN OF RAIL-SAWING MACHINE, CONSTRUCTED BY MESSRS. COWANS, SHELDON, AND CO., CARLISLE.

THE BRITANNIA IRON WORKS.

(Concluded from page 333.)

On reference to the general plan of the Britannia Iron Works, which we published on page 298 of our number for the 10th ult., it will be seen that the rail mill, we last described, is situated at O, and that in a line with it, at P, is placed the rail-sawing machine. This latter machine has been constructed by Messrs. Cowans, Sheldon, and Co., of Carlisle, and we publish a front and side elevation of it on the opposite, and a plan on the present, page. The machine is driven by an independent vertical engine of the steam hammer type arranged in the rear, as shown in Figs. 2 and 3. From the fly-wheel of this engine a belt is led to a pulley on a countershaft, A, supported by the main side frames of the machine, this countershaft carrying another larger pulley, from which a belt is led down to a pulley at the centre of the saw spindle. This spindle carries two saws 4 ft. 6 in. in diameter (marked E, E, in Fig. 3), and its bearings are mounted in a pair of brackets, B, cast in one piece with a slide capable of moving horizontally on suitable guides formed on the base plate of the machine. This horizontal movement, which serves to feed the saws up to their work, is given by attaching the slide to the rod of a piston working in the horizontal steam cylinder, C, this rod being also continued backwards, and attached to a piston working in the hydraulic cylinder, D. By means of the handle, F, steam can be admitted to either side of the piston in the cylinder, C, and the saws thus moved backwards or forwards, the rate of motion being governed by valves which regulate the flow of the water from one end to the other of the hydraulic cylinder, D. By this arrangement the rate of feed given to the saws can be governed with great nicety.

Besides driving the saws the engine at the rear of the machine also gives motion to the rollers of the travelling frames, these rollers serving to convey the rails to and from the machine. Referring to the plan, Fig. 3, it will be seen that at one end of the crank shaft is a spur wheel gearing into another spur wheel or a countershaft, G. This latter shaft has at each end two bevels running loose on it and gearing into other bevel wheels on the shafts, H and H'. By means of friction cones actuated by the handles, I and I', either of the bevel wheels on the shaft, G, may be caused to revolve with it, and thus the shafts, H and H', can each of them be driven in either direction. At the front ends of the shafts, H and H', are other bevel wheels gearing into similar wheels on the lines of shafting, J and J'. The latter shafts in their turn carry bevel wheels which drive the series of rollers, K, by means of which the rails are brought to and conveyed away from the saws. The frames supporting the bearings for the spindles of the rollers, K, extend away on each side of the machine for a distance of about 60 ft., reaching on the one side to the rail mill, and on the other to the rail beds, Q, Q', as shown in the general plan on page 298. The rollers, K, are 12 in. long and about the same in diameter, and are placed 5 ft. apart from centre to centre. The arrangement for holding the rails against the thrust of the saws is shown at L, L', in Figs. 1 and 2.

The whole machinery, which is well contrived, is under the control of one man, who stands on the platform shown, and it will be seen from the particulars we have given that the arrangement is such that the rails are conveyed from the rail mill, sawn, and passed on to the rail beds with the minimum amount of hand labour.

Beyond the rail beds, at the points marked R, R, R' on the general plan on page 298, are the rail-straightening presses, of one of which we give an engraving on page 351. These presses were made by Messrs. Francis Berry and Sons, of Sowerby Bridge, and they are of the usual substantial pattern made by that firm. Each press is driven by an engine attached to it, a pinion on the crank shaft of this engine gearing into a spur wheel on the eccentric shaft, which actuates the two plungers of the press. Referring to the figures, it will be seen that the anvil of each plunger is provided with a pair of friction rollers, over which the rails to be straightened are passed. These rollers are not supported rigidly by the anvil block, but are carried by slides, which are pressed upwards by springs bearing against their lower ends, as shown in the side elevation. Thus, when the pressure of the plunger comes upon a rail which is

being straightened, the rollers descend, leaving the thrust to be resisted by the blocks with which the anvil is provided. On the pressure being removed the rollers rise again, and the rail is thus supported clear of the anvil, and can be readily shifted.

Referring again to the general plan on page 298, it will be seen that at V, V, beyond the rail-straightening machines, are ranges of rail benches, there being placed close to these, at S and T respectively, rail-punching and snipping machines, while at U is a rail-ending machine, for finishing the rails to the exact length required. This machine, as well as the rail-punching machine and the snipping machine for making the square notches for spikes in flat-bottomed rails, was made by Messrs. Joshua Buckton and Co., of the Well House Foundry, Leeds, and we give, on the preceding page, a perspective view of it. It is a very neatly-designed machine of the revolving cutter type, the rail being held as shown in our engraving, and its end being operated upon by tools carried by the revolving cutter head. In sawing the rails to length while hot it is difficult to make the precise allowance for contraction, and where exact lengths are required they are left slightly long when sawn, and then cut down to the exact length, when cold, by the machine of which we are now speaking. The machine does its work quickly, and leaves a clean square end. Besides the machines just mentioned, Messrs. Joshua Buckton and Co. have also made for the Britannia Iron Works a rail-testing machine for testing the breaking strength and deflection of rails under pressures up to 40 tons, applied between supports varying from 2 ft. to 4 ft. apart.

We have now completed our account of the chief features of the Britannia Iron Works; but we should mention that, in addition to the plant for rail-making, the establishment includes workshops for the repair of the machinery employed. These are marked X, in the general plan, and comprise a smiths' shop and an engineers' shop, the latter being provided with a lathe for turning rolls, &c. As we stated in our former notice, the Britannia Iron Works have been laid out for the production of from 1300 to 1500 tons of rails per week when in full work, and in their arrangement, which has been carried out under the able supervision of Mr. J. J. Thomas, the manager, and Mr. Richard Howson, the engineer, no pains have been spared to turn to account the best teachings of recent practice. The machinery is all of the most modern types, and the establishment is in fact a model one, owing its existence to the enterprise of Messrs. Samuelson—an enterprise which deserves the best success. In conclusion, we have much pleasure in acknowledging the ready courtesy with which Messrs. Samuelson and the various makers of the plant of the Britannia Iron Works have furnished us with the detailed tracings from which the engravings accompanying our account of the works have been prepared.

THE A. B. C. WORKS AT CROSSNESS.

In the *Standard* of the 2nd September, there appeared an able article entitled "The Crossness Sewage Experiment," of which abundant use has been made in the following description of the works of the Native Guano Company, which we illustrate in a two-page engraving this week.

As all our readers know, Crossness is the spot where the southern sewage of the metropolis is pumped from the great outfall sewer into a covered reservoir, prior to its discharge at a certain period of the tide into the river. The name appears to be simply the designation of a projecting part of the southern shore of the Thames, intervening between the Plumstead and Erith marshes. Descending the river, we find the southern main drainage works, or pumping station, situated a little below Crossness point, but still very near it, the distance being about a third of a mile. The country intervening between the railway and the river is a huge marsh, only preserved from inundation by an embankment. As mentioned by Mr. Bazalgette, in his account of the main drainage of London, these marshes originally formed part of the Thames, being first reclaimed in the reign of Edward I. by the members of Lesnes Abbey. In the reign of Henry VIII. 2000 acres were flooded by the river bursting its banks, and were not recovered until the reign of James I. A similar disaster very nearly occurred in 1864, on the occasion of the explosion of Messrs. Hall's powder magazine. The pumping station is secured against the danger of inundation by being placed partly on the embankment, and partly on an artificial plateau which covers the reservoir. The area of the sewage reservoir is 6½ acres. The plateau, laid out with grass and gravelled paths, and a few shrubs and flowers, is a very pleasant-looking spot. Twenty-one cottages fringe the plateau, while on the river side is the engine house, where four engines, collectively of 500 horse power, lift the sewage from the level of the sewer into the great reservoir. The daily quantity of sewage now discharging at Crossness is, on the average, about 50,000,000 gallons, or more than 228,000 tons. The lift, we may observe, varies from 10 to 30 ft., according to the relative levels of the water in the sewer and in the reservoir.

The experimental works of the Native Guano Company are on the eastern side of the Crossness pumping station. The land occupied by these new works belongs to the Metropolitan Board, and the company have simply obtained permission to occupy the site for twelve months. Should the experimental works prove a nuisance, the company will be liable, by their agreement, to have the process at once stopped. All the risk is theirs, and the conditions are stringent. The Native Guano Company erect their buildings and find their machinery, chemicals, working staff, &c., at their own cost, while the whole of their operations at this spot are to be under the surveillance of the Metropolitan Board.

It is intended by the Native Guano Company only to operate upon a small portion of the sewage, amounting to 500,000 gallons in the four-and-twenty hours, which will be drawn from the channel or culvert through which the sewage flows into the great reservoir. The quantity thus taken will therefore be the fairest possible sample of the sewage generally, and will amount to 1 per cent. of the whole. From this point, which is some 16 ft. or 18 ft. below the surface of the ground, the sewage will flow through a large pipe into the sump of the pumping engine on the works of the A. B. C. Company. This engine, made by Messrs. Appleby Brothers, performs various operations required in the process, and is a 15-horse high pressure horizontal engine.

The pump is "Murray's chain" attached by a closed connexion to the sewage pipe so that the level of the sewage in the pump varies with that in the great reservoir.

The sewage then flows from the pump head through a cast-iron rising main into the mixing room, where there is a cylinder, M, and four A. B. C. mixing pits, all fitted with mechanical stirrers. The cylinder contains one minute's supply of the sewage, which enters at the bottom, and rising with the A. B. C. mixture, whilst being gently stirred, overflows by a trough into the settling tanks. The four A. B. C. mixing pits are fed by troughs from the crushing mill, C, in which the ingredients of the A. B. C. mixture are pounded up with 82 per cent. to 84 per cent. of water. The mixture is kept stirred in these pits, and is drawn from them by gravitation into a small pumping well, P, fitted with duplicate earthenware pumps (Doulton's), having a variable stroke, each capable of throwing a quantity of the mixture equal to from ¼ per cent. to 1½ per cent of the sewage to a hopper, placed at such a level that it flows thence by gravitation into the rising main containing the sewage at the point where it enters, M, the mixing cylinder.

It may be well here to explain what is included in the mixing of the A. B. C. compound. Ten thousand grains of raw sewage are to be mixed with from 16 to 18 grains of the A. B. C. ingredients, exclusive of water. The compound comprises from two to three grains of crude sulphate of alumina, three grains of animal charcoal, ten grains of clay, and one or two grains of blood. These are mixed with 82 or 84 grains of water, making therefore a total of 100 grains, or one per cent. of the 10,000 grains of raw sewage. The sulphate of alumina is obtained in a very cheap form. Clay is first of all dried by being placed on a surface heated from beneath by waste heat from the engine furnace. When the clay is dry and hot, it is mixed with sulphuric acid, which seizes on the alumina in the clay, and forms the sulphate. The one or two grains of blood mentioned in the list are mixed with the ten grains of clay, this clay being distinct from that which assists in producing the sulphate of alumina. The blood is that of a living animal, coagulation being fatal to the required properties. Mixed with the clay, the blood remains moist until wanted for use. To secure these advantages, the clay is sent in tubs to the slaughter-houses. The operation in the cylinder is simply one of mixing, so as to blend the sewage and the solution. The back of the mixing-room, where the cylindrical tank is placed, abuts upon the western end of six out-door tanks, constructed of concrete, and ranged side by side. The floor of these tanks is level with the ground, the walls rising up so as to form an enclosure about 150 ft. in length. Each tank is 50 ft. long by 20 ft. wide, and 8 ft. deep. The sewage, mixed with the solution of A. B. C., will flow from the top of the cylindrical tank along a channel which traverses the edge of the range of tanks. From this channel, by means of suitable outlets, the sewage thus prepared or "dosed" will be allowed to descend into each tank as may be required. Once admitted into one of these settling tanks the fluid will begin to throw down its precipitate. Each tank when full will be allowed to remain for six hours, and at the end of that time the floor of the tank will be covered with a deposit of sewage-mud, while all above will be clear water. By means of pipes and valves the clear fluid will then be run off, taking its course outside along an open channel a little below the level of the tank floors. This channel is of brick, lined on the bottom with cement. It is very shallow, and has a width of 4 ft. It runs eastward, parallel with the river, for a distance of 400 ft., when its course is broken by half-a-dozen little falls, intended to produce cascades. Including a couple of bends, the entire course of this effluent water canal leading to the Thames is about 470 ft.

In drawing off the water from the tanks the lower portion would be more or less charged with the "flakes" formed in the precipitations if any disturbance were allowed. To meet this floating flexible weirs have been especially designed and after trial have been found to work well. There are two fitted to the 6 in. pipe in the bottom of each tank. By the detail illustrated it will be seen that they rise and fall vertically by means of a float and weights, the former serving also to keep back any floating substances, and the latter working on the guide rods so as to regulate the depth of the weir below the surface as may be found desirable.

At the eastern extremity of the tanks preparation is being made for the construction of filter beds, in order to afford the effluent water the highest degree of filtration. Several methods of filtration will be adopted, so as to test their relative merits. A degree of purity ample for a tidal river is expected from the operation of the large tanks alone; but further purity in different degrees will be obtained by means of the filter beds, so as to suit all requirements.

The effluent water will be used for the supply of the engine boilers and the cistern over the portico of the offices, which last will supply the water required for all purposes except drinking. The space near to the works is to be laid out with turf and shrubs, so as to present a neat and attractive appearance. At the western end of the tanks is a neatly designed building, within which is the company's board-room, the laboratory, the chemical store, clerk's office, the mixing-room, and other apartments. The main building is simply of one storey, and is principally of wood, but has a very presentable appearance. We have spoken of the mud deposit in the precipitating tanks. The effluent being run off to the north, the mud is afterwards drawn off by an outlet in each tank on the south. The discharge of the mud will be facilitated by men armed with brooms, sweeping the floor of the tank. The mud thus removed will enter a channel, and thence be led into a range of covered acidifying tanks, running parallel with the line of precipitating tanks. The acidifying tanks are—like the others—six in number, but of course are much smaller, as they only receive the mud. Each of the smaller tanks measures about 12 ft. square by 4 ft. deep. The mud will remain here a certain time, and as a further settlement will take place, the supernatant water will be run off and returned to the pump sump. Sulphuric acid will then be mixed with the mud remaining in the tanks, in order to fix the ammonia. This being done, it is asserted that the mud never parts with its ammonia until it is absorbed by vegetation.

The quantity of acid used in the acidifying tanks is not large, being one pint of acid to a ton of mud. The next step is the drying process, hitherto the great difficulty with all chemical processes. The Hastings Sewage Company, working on the A. B. C. system, dry their mud on an iron floor, heated from beneath by waste steam, the mud being further acted upon by the waste products of combustion, drawn over it by a fan. The drying floor is closely roofed in, and the products of combustion, after passing over the mud, are conducted, together with the steam exhaled by the mud, into a vessel or tank, where they are made to pass through water, so as to deprive them of any noxious properties before escaping into the air.

The floor has been patented by some of the officials of the company and pending the result of some experiments on other modes of drying, is being adopted at Crossness. A drawing is given to show the construction.

It is computed by the company that the 500,000 gallons of sewage to be treated daily at Crossness will result in the production of 4 tons of native guano. This is below the Hastings result, where 100,000 gallons of sewage produce 1 ton of manure. But the London water supply is large, and there is considerable percolation of subsoil water into the long lines of intercepting sewers. It will be observed that the company at Crossness have undertaken to receive the sewage in a continuous flow, so as to represent the maximum difficulty in dealing with the sewage of towns. The company will also take as much at night as in the day, each hour being burdened with a twenty-fourth part of the daily total. If the sewage which reaches Crossness during the night is materially weaker than that which arrives in the day the company are placed at a manifest disadvantage by this arrangement. As to the constitution of the manure, we may observe that at Hastings 7 tons of native guano contain 3 tons 12 cwt. of A. B. C., the remaining 3 tons 8 cwt. being, therefore, due to the sewage. The proportions in this case, being as 72 to 68, are nearly equal. As an approximation, we might assume an actual equality in regard to the London sewage. If this be so, the 4 tons of native guano to be produced daily at Crossness would contain 2 tons of sewage deposit, obtained from 2232 tons of liquid.

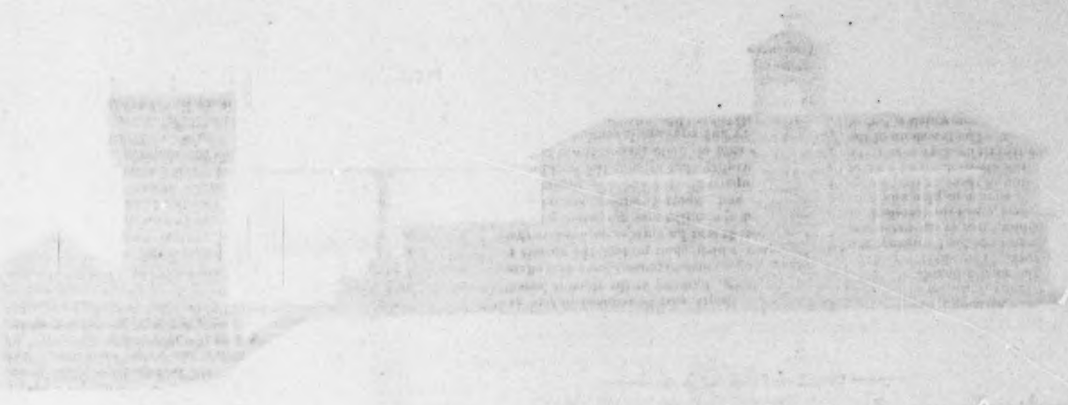
The Crossness Works are rendered expensive by peculiar circumstances, being intended as model works, and including many things which would be quite unnecessary in an ordinary case. Another feature in the undertaking not yet mentioned is the rental of about 7 acres of land in the vicinity of the works, in order to try the effect of the native guano on various kinds of crops. It is desired that this part of the operations should also be under the supervision of the Metropolitan Board, so that all the results may receive the stamp of authority, and be placed beyond suspicion.

Messrs. Shelford and Robinson, of Westminster, are the engineers, the contractors being Mr. William Webster, Mr. J. T. Chappell, and Messrs. Appleby Brothers, for the masonry and earthwork, for the buildings, and for the machinery respectively.

New Alpine Railway.—According to the *Swiss Times*, the State Commission has approved the convention concluded at Bale touching the Splügen Railway, and has decided on submitting the question of the subvention of four millions to the popular vote. The communes will make a free grant of the land for the undertaking.

Mongols *v.* Deep-sea Cables.—A novel obstruction to the spread of civilisation to China is reported. A branch of the new system of cable telegraphy has actually been taken up and stolen by the Chinese. This is the very latest style of ways that are dark and tricks that are vain which we have had of the heathen Chinese.

Eastern of France Railway.—At the close of 1870, the Eastern of France Railway Company possessed 905 locomotives and 796 tenders. Some of the locomotives experienced serious injuries during the war, but none of them disappeared. As regards the company's other rolling stock, however, 12 passenger carriages, 14 baggage vans or horse boxes, and 298 goods trucks were still missing at the date of the last return upon the subject.



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(For Description, see P

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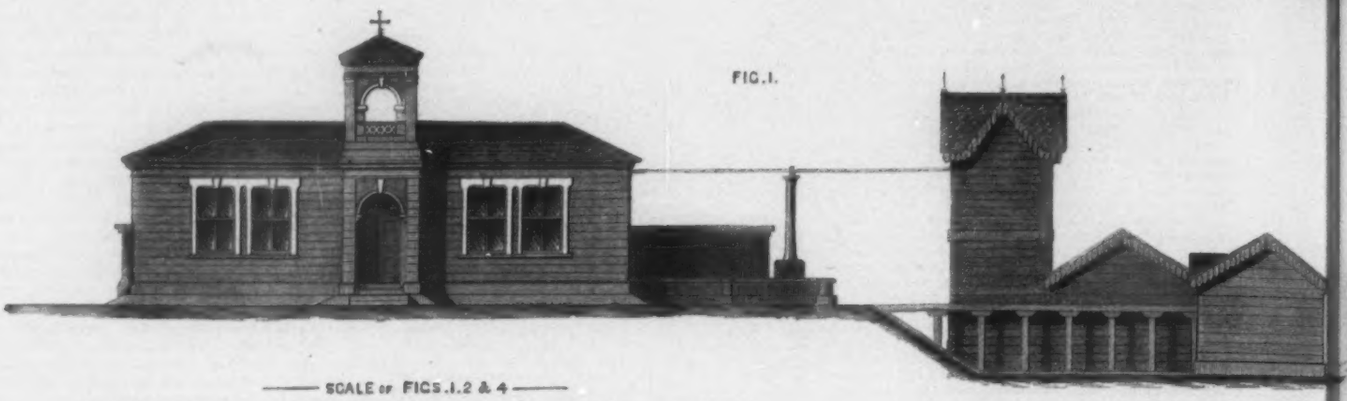

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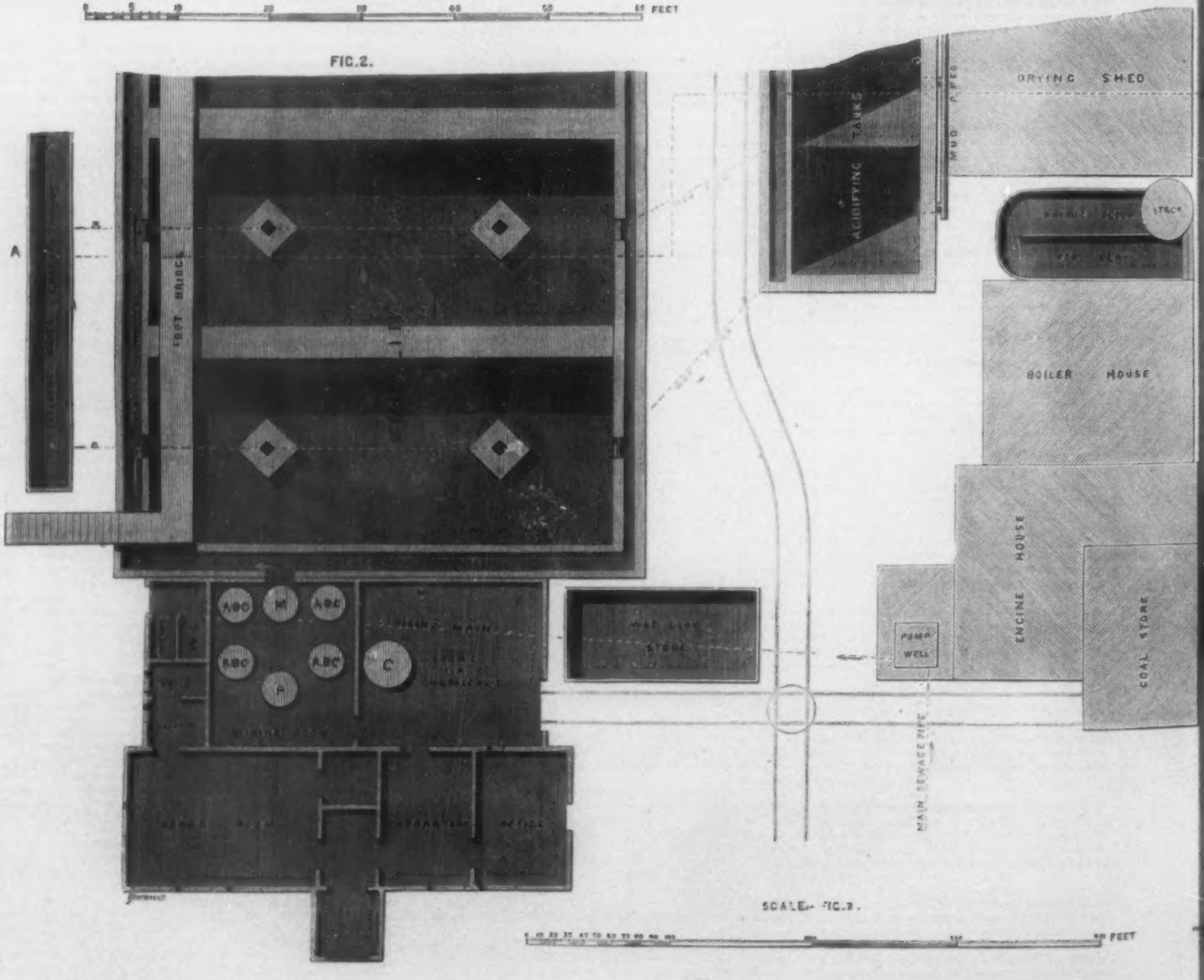
FIG. 2.



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NT OF SEWAGE BY THE A. B. C. PROCESS.

SHELFORD AND ROBINSON, ENGINEERS, WESTMINSTER.

...ue Page 356.)

FIG. 3.

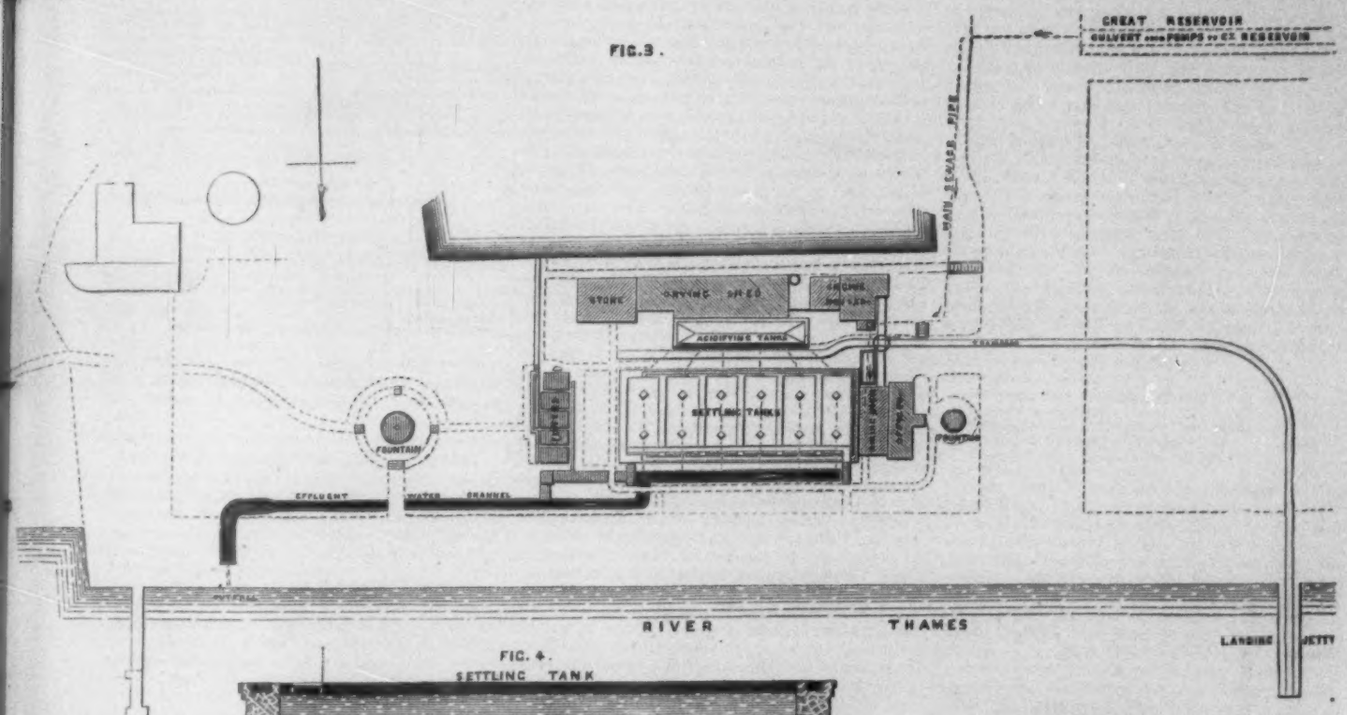

FIG. 4.

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ACIDIFYING TANK

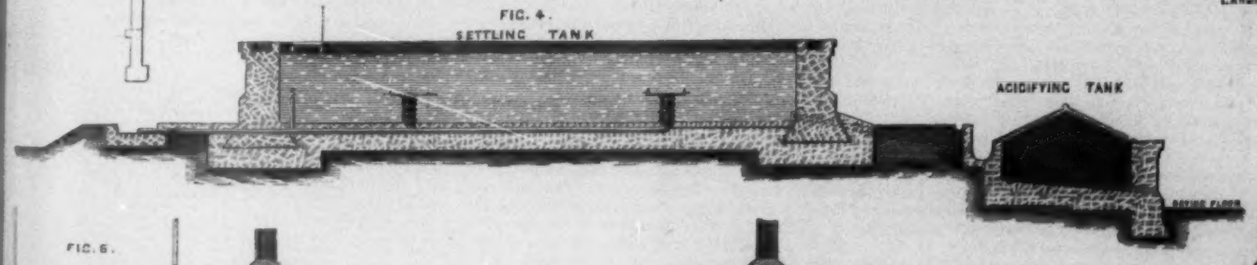


FIG. 6.

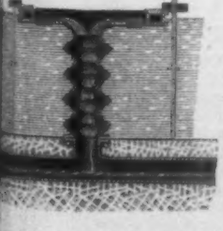
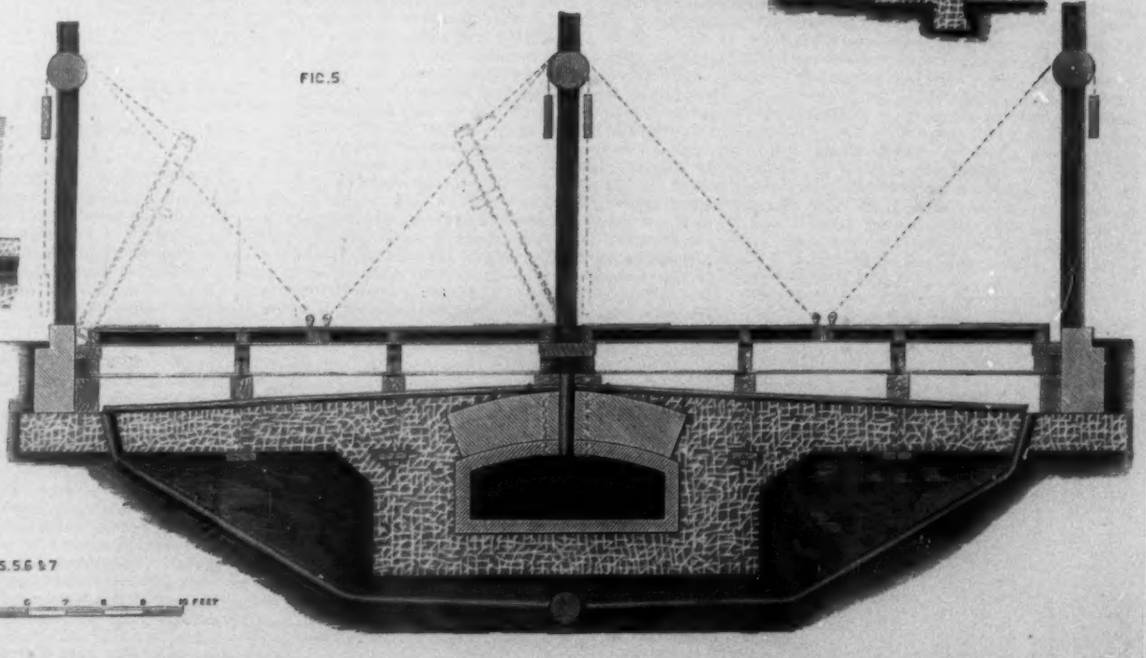


FIG. 5



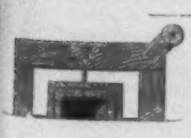
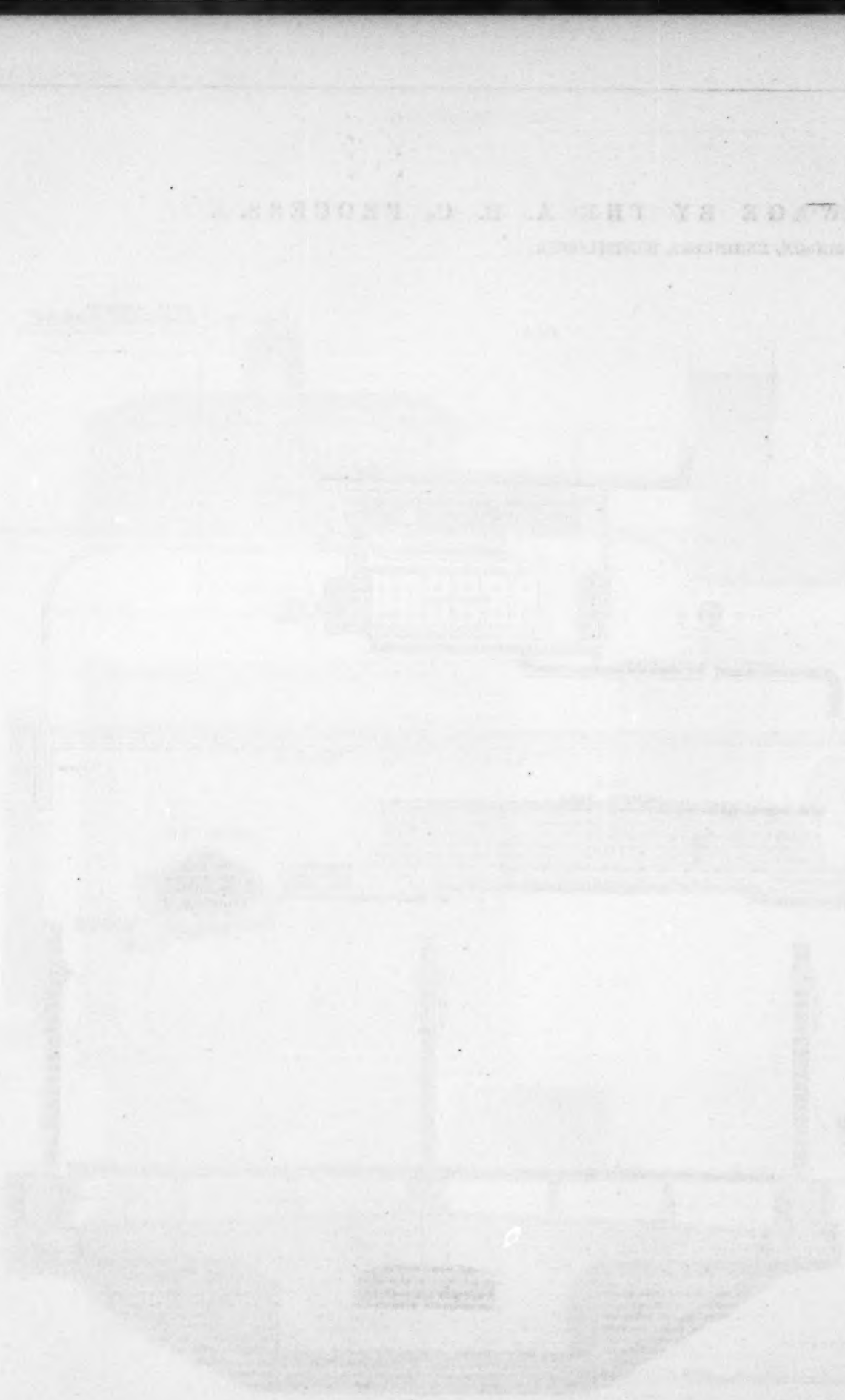


FIG. 7.

SCALE of FIGS. 5 & 7



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NOTICE OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 5, at 8 p.m. "On the Stresses of Rigid Arches and other Curved Structures." By Mr. William Bell, M. Inst. C.E.

SOCIETY OF ENGINEERS.—Monday evening, December 4, 1871. A paper will be read on "Floating Breakwaters," by Mr. Thomas Cargill, C.E. There will be a ballot for the election of new members. The chair will be taken at half-past seven o'clock precisely.

THE "ENGINEERING" DIRECTORY is published this week on the thirteenth page of our advertisement sheet.

NOTICE TO AMERICAN SUBSCRIBERS.

In consequence of the great increase in our American connexion, we have found it necessary to establish a branch office in the United States. Communications may in future be addressed to MR. GEORGE EDWARD HARDING, C.E., *of* 176, *Broadway, New York, who is our accredited representative.*

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of* 1*l.* 14*s.* 8*d.* ($8.32, *gold*) *per annum, payable in advance.*

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ENGINEERING.

FRIDAY, DECEMBER 1, 1871.

ROLLING STOCK MAINTENANCE.

THREE weeks ago we published a Table giving the particulars of the locomotive expenditure on twenty of our principal railways for the half-year ending on the 30th June last, and in the present number we give a companion Table containing details of the expenditure on carriages and wagons on the same lines and for the same period. It unfortunately happens, however, that from the form in which the accounts of English railway companies are made out this second Table is far from being able to yield such valuable data as could be obtained from that which preceded it; but while one of our chief objects in writing about it here is to point out some of the fallacies attendant upon the ordinary modes of comparing the cost of maintaining rolling stock on different lines, yet we hope to deduce from the Table data, which, if not of great engineering value, will, we trust, possess some interest.

The great popular unit of comparison for railway working expenses is "per train mile;" but in the case of the cost of maintenance of carriages and wagons, this unit is a most unreliable one. In the case of locomotive expenses it is far less so, as the number of miles run per engine is known, although even in that case it is not perfect. The great fault of the "per train mile" unit as applied to the repairs and renewals of carrying stock is that it takes no account of the number of vehicles forming a train. Evidently, if one line works trains averaging twice the length of those on another line, the cost of maintenance "per train mile" in the former instance would be twice as great as that on the latter, even if the cost "*per vehicle* per mile" should be the same in the two instances. It is, however, not only the average number of vehicles composing a train which has to be taken into consideration, but also the average load carried per vehicle. The cost of maintenance of any carriage or wagon may be considered as made up of three amounts, the first being due to the deteriorating effect of time; the second, to the wear and tear caused by the transit of the vehicle itself over the rails; while the third, is the addition to that last mentioned quantity due to the effect of the load carried. It is impossible in practice to completely separate these three items of cost; but it is quite practicable to ascertain the average number of passengers or tons of goods carried per vehicle, and obtain data from which the actual cost of rolling stock maintenance "per passenger carried per mile" or "per ton of goods per mile" could be calculated. We have said that it would be quite practicable for railway companies to give such data as we have just mentioned; but we need scarcely add that no such data are afforded by the accounts of English railway companies as laid before their shareholders and the public. Hence it is that for the purpose of ascertaining the relative values of different systems of constructing and maintaining rolling stock, these accounts are comparatively useless. With American railway accounts it is far otherwise. We have now a number of such accounts before us, and in many of them are given—besides the particulars usually contained in English reports, and a vast amount of detailed information respecting the distribution of the traffic and expenses which would astonish an English shareholder—the total passenger traffic reduced to the equivalent "number of passengers carried one mile" and the goods traffic similarly reduced to the equivalent "number of tons of freight carried one mile." Some of the reports also give the average number of vehicles in the trains of various classes, the average number of miles run per passenger car and per freight car, the average weight of the passenger and goods trains, and the average cost of transportation per passenger per mile and per ton of goods per mile. If such data as these were available with regard to all our principal English lines, even for a single half year, it would be possible to deduce some most valuable results bearing upon the different systems of constructing and repairing rolling stock and of managing the traffic. These results would be of great service to railway engineers and superintendents generally; but at present they are practicably inaccessible, and we can, therefore, only regret their inaccessibility and make the best of the information which is available.

Turning to the Table which we give on page 349 of the present number, and comparing it with the data contained in that which we published three weeks ago, one of the first facts which strikes us in the approximately constant relation which exists between the train mileage and the number of vehicles employed, even in the case of lines varying widely as to the nature of their traffic. Thus if, for example, we take the passenger train mileages on the London and North-Western, the Midland, the Great Northern, the Great Western, the North-Eastern, the London, Chatham, and Dover, the North London, the London and South-Western, and the Great Eastern Railways* during the first half of the present year, and divide these numbers by the numbers of passenger vehicles respectively in use on these lines, we get the following results.

RAILWAY.	Passenger train mileage per half-year.	Number of carriages.	Passenger train mileage for half-year ÷ number of passenger vehicles.	Passenger train mileage for half-year ÷ by length of line worked.
London and North-Western ...	5,213,654	3694	1879	3,996
Midland	3,662,140	2352	1557	2,706
Great Northern	1,966,832	1279	1539	3,475
Great Western	3,950,935	2699	1475	2,721
North-Eastern	2,875,427	1949	1475	2,196
London, Chatham, and Dover	971,043	671	1447	7,087
North London	568,339	396	1427	24,710
London and South-Western ...	2,264,786	1750	1361	3,660
Great Eastern	3,672,691	1551	1304	2,327

* These train mileages were given in the Table published in our number of the 10th ult.

The comparatively slight variation in the figures contained in the last column but one of the above Table, even in the case of lines differing so widely in the nature of their traffic as the London and North-Western and the North London, is at first sight somewhat remarkable; but it is accounted for by the fact that the effect of the long runs made on the former line are compensated for by the number of hours per day during which the trains are kept at work on the latter. The last column of the Table contains, as will be seen from its heading, the number of miles run with passenger trains during the half-year per mile of line worked. These figures give an approximate idea of the relative intensities of the traffic on the different lines, and when taken in connexion with the figures in the fourth column they tend to show that this intensity has little or no effect upon the quantity of rolling stock required to accommodate a given amount of traffic.

We have not included the Metropolitan Railway in the abstract Table of which we have just been speaking, because the nature of the rolling stock used on that line renders it an entirely exceptional one. The long carriages in use on the Metropolitan are each practically equivalent to two ordinary carriages, and for this reason alone we should expect the quotient corresponding to those given in the fourth column of the above Table to be about twice as high as those obtained for other railways. In reality it is still higher than this, as the subjoined figures will show:

Metropolitan Railway:	
Passenger train miles per half-year ...	728,794
Number of carriages	180
Passenger train mileage for half-year ÷ number of passenger vehicles ...	4049
Passenger train mileage for half-year ÷ by length of line worked ...	42,867

If we consider each of the carriages on the Metropolitan to represent two ordinary vehicles and divide the passenger train mileage for the half-year by 360 instead of 180, we still get 2024, a figure more than 25 per cent. higher than the average of those given in the foregoing abstract Table. This result tends to show either that the rolling stock on the Metropolitan Railway is worked harder than that on any other in the kingdom, or that the number of vehicles per train (even if each of the long Metropolitan carriages be counted as two) is correspondingly below the average. The high engine mileage obtained on the Metropolitan Railway inclines us to the belief that the stock is really far harder worked on that line than on railways generally, but the data available do not enable us to speak decisively on this point.

The South-Eastern Railway is also an exceptional line, the quotient obtained by dividing the passenger train mileage for the half-year (1,333,589 miles) by the number of passenger vehicles, namely, 1761, being but 757, a number equal to but about half of the average result recorded in the foregoing abstract Table. We shall refer to this peculiarity hereafter.

In the case of the goods traffic a similar relation is also observable between the number of vehicles possessed by each railway and the number of miles run with goods trains, although the quotients obtained by dividing the latter number by the former are in this case more variable than those obtained from the figures relating to passenger traffic. Thus in the case of the nine lines referred to in the former abstract Table we get the following results when the data relating to goods traffic are dealt with.

RAILWAY.	Goods train mileage per half-year.	Number of goods vehicles.	Goods train mileage for half-year ÷ by number of goods vehicles.	Goods train mileage for half-year ÷ by length of line worked.
Midland	5,586,375	19,839	281	5654
Great Northern	3,640,204	10,408	253	4666
London and North-Western ...	6,594,502	30,334	217	4122
Great Western	4,219,311	19,653	214	2884
North London	100,022	489	204	4349
Great Eastern	1,829,151	9,180	200	2247
London and South-Western ...	853,926	4,969	171	1234
London, Chatham, and Dover ...	155,265	1,036	149	1120
North-Eastern	5,434,905	63,951	85	4243

The exceptional quotient recorded in the fourth column of the above Table, in the case of the North-Eastern Railway, is no doubt due to the immense number of very small hopper coal wagons yet existing on that line, these wagons having, from their small carrying capacity, to be run in very long trains. The same cause accounts for the exceptional number of vehicles per mile of line worked possessed by this railway, as shown by the Table on page 349.

Turning now to the cost of maintenance per vehicle, as given in the Table on page 349, we find that these figures bear no apparent relation to the train mileage, and, in the absence of any data as to the mileage per vehicle, it is impossible to deduce from them any facts of especial value. It may be remarked, however, that there is some sort of irregular relation between these figures and the quotients given in the fourth column of the first of the preceding abstract Tables. The cost of maintenance per carriage per half-year is, of course, greatest in the case of the Metropolitan; but if allowance be made for the great size (to which we have already referred) of the carriages on that line, the charge at once sinks to very little above the average. This is somewhat remarkable, as, from the frequent stops made by the trains, and from the continual change of passengers, the carriages on the Metropolitan Railway are subjected to exceptional wear and tear. The same causes also tend to materially raise the cost of maintenance in the case of the carriage stock of the North London line. One point which is certain to attract attention in glancing down the column recording the expenditure per carriage per half-year, is the small sum set down for the South-Eastern line. This low figure is difficult to account for, if we suppose the carriages to have been efficiently maintained, although it is, no doubt, to some extent due to the same causes which produced the low quotient obtained in the case of this railway, by dividing the passenger train mileage for the half-year by the number of passenger vehicles.

Dealing now with the average results, we find that the mean cost of maintenance per vehicle per half-year is, in the case of the carriages, 12.6*d.*, and that of the wagons 2.16*d.*, or 25.2*d.* and 4.32*d.* per annum respectively. If we take the average values of the vehicles at the amounts deduced by Mr. R. Price Williams from the extensive data collected by him, namely, 189*l.* per carriage and 76*l.* per wagon, we find that the cost of maintenance forms, in the case of the passenger vehicles, a charge of 13.33 per cent., and in that of the goods wagons a charge of 5.68 per cent. upon their first cost. These results, deduced from the accounts of a large number of railways for a single half-year, agree very closely with those deduced by Mr. R. Price Williams from the accounts of a smaller number of railways extending over a longer period.

COOPERS HILL COLLEGE.

The syllabus of the course of study just published by authority of the Civil Engineering College at Coopers Hill, gives a fair insight into the opportunities for instruction which will be given to the students who avail themselves of the facilities afforded by that Institution. The examinations, which will take place at the end of each triennial course, will be divided into four parts; for these a total minimum of 100 marks will be accepted, the maximum number being 300; but it is understood besides, that proficiency in certain special and optional studies will be demanded to the extent of 50 marks, making the total minimum 150.

The following Table shows the different divisions of branches, and the number of marks belonging to each:

Branch.	Minimum marks.	Maximum marks.	Optional subjects.	Total marks.
Engineering ...	64	174	80	254
Mathematics ...	18	72	60	132
Natural science...	10	30	30	60
Language	8	24	30	54
Totals ...	100	300	200	500

The engineering branch is spread into eight subdivisions, which are supposed to include everything necessary for the student to acquire, and which, in point of fact, include a great deal more than any student can possibly acquire. To the first subdivision—that of "descriptive engineering"—45 marks are allotted, 18 being the lowest qualification number. Descriptive engineering includes a complete knowledge of all constructive material—stone, brick, timber, and metals—the natures and modes of obtaining and preparing them for use, in the greatest detail, as well as a practical knowledge of their various applications. These are arranged in various divisions, 33 in all, which branch off into hundreds of subheads, most of them of a practical and more or less valuable nature. The course of hydraulic engineering follows, and then that of mechanism and prime movers. As a practical application of the foregoing studies, the detailed designs of foundations, buildings, bridges, tunnels, roads, railways, and coast defences are introduced, and form an important feature in the programme. It must be remarked that, comprehensive as the list is which we have thus briefly condensed, special attention is paid to the peculiar requirements of engineering practice in India, and a desire is evinced to make the student partially acquainted with materials and the modes of dealing with them, that he will find most useful in the probable field of his ultimate usefulness.

The second subject in the engineering branch is surveying; for this 30 marks will be allotted, 12 being the qualifying minimum. Architecture occupies quite a subordinate rank, 8 and 3 being respectively the highest and lowest number of marks given or accepted. It is otherwise, however, with geometrical drawing and estimating, in which subject the numbers are 42 and 14, and this branch includes the course of geometry and its subsequent application to civil engineering, mechanical and architectural drawing. An examination in accounts finishes the engineering section for the first and second year. During the third annual course the student enters into the practical phase of his preliminary career, that is to say, the two first terms are to be passed in pupilage to a mechanical or civil engineer. The few months thus devoted to practical study will doubtless have a certain amount of value, but a value of comparative insignificance. Finally, and as a test of ability, during the last examination the student is to work out a "project," that is, to make a survey for a road, railway, or canal through a given district, to prepare estimates, specifications, and drawings of all the works that would be required upon this suppositious undertaking, and, by doing so, put to the test the knowledge he has achieved previously in the engineering branch of the college.

In the second part of the programme—that of pure and applied mathematics—36 marks will be allotted, and 9 accepted, and in applied mechanics the same number. This latter includes sixteen divisions, with very numerous subheads.

To the third part—that of natural science—20 marks is the full number, and 10 the minimum. In this part the subdivisions are arranged in their due order, including chemistry, metallurgy, magnetism, statical and voltaic sound, electricity, light, heat, geology, and mineralogy.

In the special subjects suggested for examination an opportunity will be taken of ascertaining the advancement that the student has made, by putting him to the test of a practical application of his studies, and the result of this will probably indicate the capacity he may possess for any given subject, and his consequent suitability for a special occupation when he is sent to India. The examiners will doubtless exercise a wise discretion in selecting the questions for the examination. The syllabus hints at an almost overwhelming mass of instruction to be given, and if the studies of the pupils are not judiciously directed, there will be danger of their acquiring a superficial acquaintance with a great number of subjects, instead of a practical and well-grounded knowledge of a few. That they should become really useful members of the profession and valuable assistants in the Department of Public Works in India, the latter is the end to be achieved.

THE 35-TON GUN.

As briefly mentioned by us last week, the 35-ton gun has gone through the last stage of its trial at the proof butts, Woolwich Arsenal. The chief point in the final experiments was to test the new iron carriage upon which the gun has recently been mounted. The trials took place yesterday week, and, as promised by us, we now give particulars of the carriage and details of the practice. The carriage was designed by Captain R. A. E. Scott, R.N., upon his compound pivotting principle, and is constructed of cast and wrought iron. The skeleton of the carriage is of cast iron, plated with wrought iron, the latter material being also exclusively used in those parts which receive the concussion of the gun after a shot. In other words, the cast iron is so disposed as to take the vertical strain due to the weight of the gun, and to give rigidity to the structure, whilst the elasticity of the wrought iron is utilised to absorb the shock of, and to receive the compressive strains due to, firing. The carriage weighs 11 tons, with gear complete, and is 9 ft. in extreme length at the base. The trunnion blocks are of Vickers's homogeneous mild steel, which is the first application of that metal to the purpose at Woolwich, and so far the experiments have proved it to answer satisfactorily. The gun is carried in a saddle-piece, the ends of which work in slides in the cheeks of the carriage, and have a step arrangement for giving the gun three different planes of elevation.

The weapon is capable of an extreme elevation of 17 degrees, and a depression of 7 degrees. To obtain the greatest elevation the gun is set on the lowest of the three steps, whilst for giving it the lowest depression it is raised to the highest step, the intermediate step serving for adjustment to intermediate elevations. The gun in its saddle is raised or lowered, as may be necessary, by means of a powerful hydraulic lifting jack, which, however, is not attached to the carriage, as in previous cases, but is unshipped after use. The gun, in pivotting, will be controlled by bow compressors, one of which will be used as a brake in running the gun in and out when working in its turret. The carriage runs on two pairs of gun-metal rollers, the rearmost pair being raised when the gun has been run out for firing. For this purpose they are fitted on an eccentric axle, and are brought into action by lifting the rear portion of the carriage by means of a small hydraulic apparatus which is fixed inside the framing of the carriage, and worked from the platform of the turret. The front pair of rollers are fixed in the framing, as they carry nearly the whole weight of the gun and carriage. They are brought so close down upon the slides that the raising of the rear of the carriage is sufficient to bring them to their bearings.

At Woolwich the carriage was mounted on inclined timber ways, 30 ft. long, and set at an angle of 8 degrees. The ways were each formed of two balks of 12 in. timber, placed vertically, and covered with strips of ½ in. iron plate. The timbers were well braced, and the inside ends of the framing were fitted with six india-rubber buffers to take up the recoil after firing, if necessary, and to receive the carriage when run out for a shot. The recoil here was controlled by the angle of the slides, but of course in the turret it will be taken up by the compressors.

The practice yesterday week was made from this platform, when four rounds were fired. The first round was with 115 lb. of Waltham Abbey pebble powder, and a 700 lb. flat-headed proof shot. The recoil was 7 ft. 6 in., with a velocity of 1284 ft. per second. The powder pressure at the base of the bore was 28 tons, and that at the vent 20.8 tons per square inch, as indicated by the gauges. The second round was fired with an increased charge of 120 lb. of pebble powder, and the same weight of projectile. The recoil was 7 ft., the velocity of shot 1322 ft., the pressure in the breech 21.6 tons, and that at the vent 20.8 tons. The third round was fired with the same weight of powder and shot as the previous one. The recoil was 6 ft. 9 in., the velocity 1315 ft., the breech pressure 32.4 tons, and the vent pressure 25.8 tons. The fourth round was fired under the same conditions as the last; the recoil was 6 ft. 7 in., the velocity 1340 ft., the breech pressure 40.6 tons, and that in the vent 31.6 tons. Subsequently to this practice a few more rounds have been fired, and they bear out the results given above.

It will be seen that the recoil became less at each succeeding round. This was due to the circumstance that the wrought-iron plating of the carriage was left slightly deeper than the cast-iron bearings of the framing, and these edges, working upon the wrought-iron plates of the ways, set up an amount of friction which increased with every round, the edges of the plates of the carriage cutting grooves into the plates of the slide. This is, of course, a matter which can easily be remedied by planing the edges of the cheek plates, and so bringing the carriage to its proper bearings. In all other respects the carriage worked exceedingly well, and was pronounced by the officials present to be satisfactory. As regards the question of powder pres-

sure, it will be seen to vary very considerably in the last three rounds under precisely similar conditions of firing. Taking round two, we find a breech pressure of 21 tons, which, by the way, is less than that obtained with the first charge of 115 lb., or 5 lb. less powder. Round three gave a breech pressure of 32.4 tons, whilst in round four it ran up to 40.6 tons. It is not possible to ascribe so great a variation of pressure to the powder, which was all from the same parcel; we must, therefore, conclude that it either results from some local intensification or disturbance of the gases, or from defects in the apparatus used for taking the pressures.

We do not find much to support the first of these conclusions, although this solution is strongly insisted on by some. We conceive the space occupied by the powder charge at the moment of combustion to be too limited to allow of any local intensification, such as would account for the above differences in pressure. Besides, there is also a proportionate advance in the vent pressures, which at first sight would appear to indicate that the high pressures were due to the jamming of the shot at the moment of explosion. This would cause the powder to be confined in a smaller space during combustion than if the shot had moved with the first pressure of the gas, and had given greater space for the powder to be consumed in. But when we observe the irregularity of the pressures throughout, and see that with 115 lb. of powder 6.4 tons more pressure is obtained per square inch than with 120 lb. in the next round, we cannot believe otherwise than that the pressure gauges are yet imperfect, notwithstanding the time and care that have been bestowed on them in order to render them true registers of pressure. To our mind the defect lies in the copper cylinder or pellet used to take the compressive strain of the explosion. These cylinders, which are solid, are acted on by a piston forced upon them by the gases in the chamber of the gun. Now, although the bars from which these cylinders are cut are carefully tested by examples, the copper having been as carefully prepared, we cannot conceive it possible that every pellet made from a given bar would, if tested by ordinary means, give precisely the same results, any more than two strips cut side by side from an iron plate, or two lengths cut from a steel rod will. Hence we attribute these discrepancies to the want of homogeneity in the metal, which renders the otherwise complete apparatus unreliable.

THE SEWAGE OF BIRMINGHAM.

(*Concluded from page 342.*)

THE committee give some particulars about the sewage farms at Leamington, Malvern, Exeter, and Cheltenham. These, however, call for no special remark.

Speaking of the financial results of sewage farming, the committee say:

"There is no doubt that large crops have been grown and sold for considerable sums per acre, but this by itself is no indication of profitable financial results; the expense which has been incurred for their production must also be known, and the silence on this head leads to the conclusion that, up to the present time at least, the general financial results have not been satisfactory. It might be otherwise if it were possible to rent or purchase suitable and conveniently situated land at its ordinary agricultural price, but this in the case of a Corporation is rarely possible, and when land, asserted to have a more than agricultural value, is purchased by compulsory powers, which often involves paying at least double, and always involves paying far more than its market price, and when, in addition to this, costly works are required to convey the sewage, and great expense in laying out the surface and drainage, it would be quite unreasonable to anticipate anything but loss, though the sewage may in itself possess considerable manurial value."

Influenced by these very prudent considerations the committee do not look with much hope to the speedy utilisation of the vast volume of the Birmingham sewage. They, therefore, pass on to the consideration of the intermittent filtration through a comparatively small area of soil, looking only to effect the purification of the effluent water. There is a sort of grim humour in the statement by which the committee establish the fact that filtration through soil will sufficiently purify sewage. They say that the practicability of purifying sewage to such an extent as to warrant its admission into rivers "is already sufficiently proved, not only by the experience on sewage farms where the bare fallows are heavily irrigated, but by the well-known fact, already referred to in the first part of this report, that the well waters of this town as well as of all midden towns where water is obtained from surface wells, is very little else than filtered sewage."

The justice of the latter part of this quotation is amply established by the results of a series of analyses of the well waters of Birmingham made by Dr. Hill, the borough analyst. In the Table of these analyses Dr. Hill gives minute particulars concerning twenty-seven different samples of water taken from as many wells. It is only necessary for the present purpose to state a few of the facts given. The total grains per gallon of solid matter exhibit such quantities as 256.48; 301.50; 380.24; and even 507.92. The volatile and combustible matter amounts to as much as 43.16 grains per gallon; chloride of sodium reaches 67.93 grains; nitric acid shows to the extent of 30.43 grains; and some of the waters yielded much protosalt of iron. These waters are filthy considered as potable fluids, and to the fact that they are drunk may be attributed much of the mortality of the town. It is instructive to compare these waters with the effluent sewage at Merthyr-Tydvil, an analysis of which is given below.

	Solid contents.			*Nitrogen.*	
	Fixed.	Organic.	Total.	As ammonia.	Organic
Parts in 1,000,000	340	50	390	0.686	0.185
Grains per gallon	23.8	3.5	27.3	.048	.013

Mr. Hope and Mr. Bailey Denton, from the interest which they take in the question of sewage irrigation, and from their experience, are authorities to whose opinions great weight attaches. At the request of the committee both these gentlemen have furnished reports on the best mode of dealing with the Birmingham sewage. Mr. Hawksley has also reported to the committee on the same subject. These reports are very able and exhaustive, but their length makes it impossible to do more than give a general summary of the contents. Of course they each deal with many points of merely local importance. These points we shall pass over, selecting only the portions which bear a general relation to the problem of sewage purification. Mr. Hope furnishes two reports, one bearing date 11th September, 1871, and the other dated 27th of the same month. These reports may here be dealt with as practically one. After reviewing the general conditions of the problem before the Birmingham Council, Mr. Hope emphatically condemns, as quite impracticable, any attempt to *utilise* the sewage on a small scale. He very justly points out the following important facts as established by the experience of himself and others. That the *utilisation* of sewage—as distinguished from mere purification—is only a special kind of farming, and, as such, must be carried out with strict regard to physiological and commercial principles. In other words, in order to utilise sewage, it is necessary to irrigate such an area of land as shall enable the crops grown to make profitable use of the whole of the manurial properties of the sewage, and also to have a profitable market for the produce grown. Mr. Hope finds from actual practice that each acre of land will only profitably use the sewage of 35 persons as a maximum quantity, though he considers the proportion of about 20 persons per acre as the best proportion. According to the first standard the Birmingham sewage would require a minimum area of 10,000 acres, while by the second 17,500 acres would be needed. To think of obtaining even the smaller area by compulsory purchase is out of the question, as the cost would be ruinous. And supposing that the necessary land could be procured at a moderate price, there is no likelihood of meeting with a profitable market for the produce. Viewing the matter is this light, Mr. Hope, though an earnest advocate for utilisation, recommends the Town Council to forego, at least for the present, all ideas of attempting to use their sewage for farming purposes, contenting themselves with a simple scheme of natural filtration, to meet the injunctions of the Court of Chancery. At the same time he points out the practicability of laying out a small sewage farm to serve as a model, with the object of showing the neighbouring landowners and farmers what results can be obtained from the judicious use of sewage as liquid manure.

Mr. Hope's proposition is to the following effect. That the council should purchase 1000 acres of land, and laying out 250 acres as a model sewage farm, should use 750 acres simply as a gigantic natural filter. This land should all be very closely drained to an average depth of 6 ft., with pipes of large diameter. On the farm of 250 acres, Mr. Hope considers that the sewage of 10,000 persons might be *utilised*, leaving that of about 340,000 persons to be filtered on the remaining 750 acres. That is to say, use the sewage of forty persons per acre on the farm, and purify that of 453 persons per acre on the filter beds. This gives 13,748 square inches per person per annum, or, in other words, it would give a fresh area of land of only 12 in. in length, by a trifle over 3 in. in breadth for the reception of the 48.8 gallons of sewage arriving each day in respect of each of the inhabitants. Or, to take it in another way, 17,000,000 gallons per diem less the sewage of the 10,000 persons applied to the 250 acres of model farm, being equal to 73,888 tons, would give a total depth of sewage over the whole 750 acres of filter after deducting roadways, carriers, &c., of in round numbers about 1 in. each day in the year, or no less than 30 ft. 5 in. in the course of the year; but concentrated upon a third or fourth part of the area each 24 hours, this would give a depth of sewage to be applied to the land of 3 in. or 4 in. on every third or fourth day.

Mr. Hope goes on to say, that he has found by experiment, that from 40 tons to 110 tons is sufficient to moisten an acre of land under ordinary conditions. Further, that the average application on his farm, including heavy doses in winter—when he only sought to filter the sewage—and the irrigation of freshly ploughed land has only been 200 tons per acre, or 2 in. in depth. From this fact, we can judge how severe a tax the application of 3 in. or 4 in. every third or fourth day would put upon the land. Such a dose of sewage would require many hours to sink into the land, and, as Mr. Hope points out, it might often be found necessary to plough up fine crops in order to loosen the soil and prevent a serious nuisance.

As an additional illustration of the strain which would be put upon the absorbent and aërating powers of the soil, Mr. Hope points out the fact that the sewage applied to each acre of the 750 used for filtering would contain as much ammonia as 10 tons or 11 tons of the best Peruvian guano, after allowing for the interception of the fecal matter from the houses. Mr. Hope concludes his very able and lucid report by an estimate of the money value of the Birmingham sewage, rated according to the present market price of manures. The amount he arrives at as the annual value is 150,000*l.*; but he says that, although the full value of sewage as manure can be actually realised in practice, yet it is doubtful whether the council will ever succeed in so utilising the enormous volume they have to deal with, as to enable them to get this full value. And again, new discoveries in the manufacture of manures, the spread of steam cultivation on enormous tracts of land on the Continent and elsewhere, and the continually increasing importation of meat from Australia and South America, all tend to progressively lower the value of sewage as manure. But notwithstanding, Mr. Hope is firmly convinced that in time the Birmingham Corporation may realise a very immense income from the sewage of the town.

As regards the achievement of such a desirable result, it is most important to win over the farmers of the district by the example of the proposed model farm. To facilitate matters, Mr Hope offers to allow any farmers who really contemplate using the sewage to visit his own farm, where he promises them a complete course of practical instruction. Being willing to do this, in order to aid in the proper treatment of the Birmingham sewage, it is most probable that Mr. Hope would render the same help in other cases. Indeed his devotion to the cause of sewage utilisation promises to confer an important national benefit, as he has undoubtedly set the very best example in existence of what a sewage farm ought to be.

Mr. J. Bailey Denton, C.E., furnishes a report which agrees in most points with that of Mr. Hope. Mr. Denton says: "I am of opinion that 900 acres will suffice for the purification of the sewage of Birmingham. . . . . It is assumed that three series of filtering areas of 300 acres each are adopted, each of the three being sufficient to take the whole of the sewage at one time, and for a period—six or twelve

months—which may be determined hereafter, leaving the other two series at rest in the interim. I am further of opinion that this arrangement may be made a lasting one, and will render the effluent water admissible into the River Tame without any nuisance whatever. The experience at Merthyr justifies my stating that not only may crops be produced from the two series of areas which will be at rest, but that the series of areas at work may also be made equally productive. It may be desirable to show the farmers of the district what can be done with sewage in the way of ordinary irrigation, in which case 100 acres will probably suffice for the purpose, inasmuch as vegetables of a variety of kinds will be grown upon the filtering ground, and the mode of cultivation adopted will be equally instructive. If this arrangement should be carried out 1000 acres of land will suffice; but in order to secure this quantity at a suitable height it may be requisite to purchase a larger extent, and either re-sell what may be inappropriate, or hold it to be worked in conjunction with the sewaged land."

Mr. Hawksley commences his report by pointing out the essential difference between the problem of sewage purification where only small quantities have to be dealt with, and cases such as that of Birmingham, where enormous volumes of liquid have to be purified. By some calculations, which we have not space to quote, Mr. Hawksley shows that the maximum flow of sewage, when augmented by rainfall, would, in the case of Birmingham, be sometimes as much as 3,200,000 gallons per hour for a period of about eight hours. To carry off this quantity of liquid—supposed to consist of 5 gallons of storm water to 3 gallons of ordinary sewage—Mr. Hawksley recommends the construction of a conduit of ovoid form, with a vertical diameter of 7 ft., and a horizontal one of 5½ ft., and having an effective fall of 1 in 3520, for a distance of 7½ miles from the present outfall at Saltley, to a point about half a mile north-west of the village called Hams Ford. The sewage would thus flow for above 7 miles in contact with air, and at a surface velocity of 2½ ft. per second. During this journey a very considerable oxidising action would take place. To facilitate the separation of the solid matter, Mr. Hawksley recommends the addition of a small quantity of a cheap sulphate of alumina. This sulphate to be added to the sewage at Saltley, previously to its entry into the conduit above mentioned. At some convenient place in the length of the conduit, Mr. Hawksley would afterwards add such a small quantity of the milk of lime as should be found sufficient to produce an alkaline reaction. The water is then to be received into suitable depositing tanks. Mr. Hawksley says that the water from these tanks would be perfectly clear, and fit to be run direct into the River Tame: but that, for greater security against nuisance, it might preferably be used to irrigate about 1000 acres of land between Whitacre and Kingsbury. Further, inasmuch as it is very probable that the farmers would soon begin to apply for the sewage, he thinks that the corporation would in time have but a small quantity left to be dealt with on their own land. The tanks recommended would be four in number, each capable of holding a million gallons of sewage. This plan has the advantage of commanding 6000 acres of land by gravitation, and a much larger area by moderate pumping lifts; all admirably suitable for irrigation, both by the quality of the soil, and its gradual inclination of surface.

One very important fact concerning the sewage of Birmingham is specially noticed by Mr. Hawksley, namely, its weakness. The undissolved organic matter averages about 7 or 8 grains per gallon, and the dissolved organic matter about 5 or 6 grains per gallon. The London sewage contains about 30 grains of undissolved organic matter per gallon, and 15 grains of dissolved organic matter.

The concluding recommendations of Mr. Hawksley's report are:—To exclude, or at least diminish, the strongly acid and metallic liquors now poured into the sewers from various factories in the town; and to adopt an improved form of privy in place of the present offensive middens and privies. We have already given—on page 274—a summary of the recommendations to the council, which the committee have based upon these reports and their own researches; and also a copy of their estimate of capital and income for the works they recommend.

In one of the appendices of the committee's report a full statement of the finances of the present sewage farm belonging to Birmingham is given. From this it appears that from the 1st September, 1867, to 31st August, 1871, inclusive, the expenditure and receipts present the following figures:

	£	s.	d.
Receipts for four years	2,527	12	10
Payments for four years	12,256	11	7
Loss by balance	9,728	18	9

Putting out of sight the injunctions for nuisance, it must be confessed that these results are anything but cheering to the ratepayers. It is probable, and much to be desired, that the action now forced upon the council may ultimately reverse the balance of account. Before taking leave of the report of the Birmingham Sewage Inquiry Committee it is only necessary to say that the council have adopted their suggestions.

A SEA TORPEDO CRUISE.

On Saturday last a small tug-boat of about 70 tons burthen might have been seen steaming about in the Yarmouth Roads, first, on one tack and then on another, as if keeping a sharp look-out after various vessels as they hove in sight. This tug had on board General Prestich of the Russian army, and his two aides-de-camp, as well as the Baron de Grancy, military attaché of the French Embassy, and several other officers and gentlemen. She was supplied with two of Captain Harvey's sea torpedoes, and the object of her search was to find vessels against which to plant these weapons, which of course were only loaded with water to ballast them. They were, however, fitted with their exploding bolts, so that it could always be ascertained whether they had struck the ship properly or not. It will be remembered that these torpedoes are towed by a small, quick speed vessel, and are exploded (through a system of levers acting on the exploding bolt) by being brought into hugging contact with an enemy's vessel. The details of this torpedo will be found described, and the weapon itself illustrated, at page 35 of our eleventh volume. A large and a small torpedo were used on the present occasion, and two successful attacks were made upon vessels in full sail. The former was first used, and on nearing a brig the tow line, about 60 fathoms in length, was neatly dipped under her bows, and the brakes being put on contact was made between the torpedo and the bottom of the brig. The strain brought on the yard from which the torpedo was towed, and which was temporarily rigged up to a jury mast, brought down the yard by the board. The torpedo was recovered, being kept from sinking by the buoys attached to it for that purpose, and on examination it was found that the levers had been depressed, and the charge in the bolt exploded.

The small torpedo was then towed through a leading block attached to the jury mast, and with it the second attack was made. The tug bore down upon a brig from right ahead as before, and the line was well dipped under her bows. When the brakes were put on, however, the tow line parted under the vessel's keel. This was owing to the line, which was of wire rope, having become stranded, through frequent use in previous experiments. The torpedo, however, was well planted, and but for the tow line carrying away would have been brought in contact with the bottom of the brig. As in the previous case the torpedo was recovered, and was being prepared for further attacks. As, however, there were only small craft in sight, whose hulls might have been injured by the levers of the torpedo, and as the officers present expressed themselves thoroughly satisfied with the results of what they had seen, no further attacks were made. The operations were carried out by Captain Harvey, assisted by Mr. J. Vavasseur, of the London Ordnance Works. The opportunity was a favourable one for testing the efficiency of the torpedo, as there was a strong breeze and a moderately heavy sea on. The brakes and towing gear of the torpedoes—with the exception of the worn-out tow-line—proved sound, and worked well, and the experiments were successful as illustrating the fitness of the Harvey torpedo for its purpose—the destruction of enemy's vessels, provided the latter were powerless to prevent it. Although the men who worked the torpedoes were previously unacquainted with them, no hindrance occurred.

NOTES FROM THE SOUTH-WEST.

State of Trade at Newport.—Shipments of railway iron have continued to be made rather freely from Newport, principally for ports on the west coast of South America and the United States. The demand for steam coal is greater than the supply. A few cargoes of iron ore have come to hand from Spain.

The Nine Hours' Movement.—Messrs. G. K. Stothert and Co., engineers and iron shipbuilders, Hotwells, have conceded to their men the nine hours' system to commence January 1, 1872. The workmen concerned have passed a resolution thanking the firm for the cordial manner in which the concession was made.

Gloucester Wagon Company (Limited).—The Gloucester Wagon Company (Limited), is now employing about 1000 hands. On Saturday a meeting was held in one of the large workshops in regard to the shortening the hours of labour. The men admitted that they were well treated, and the result of the meeting was that a delegation was appointed to wait upon the sub-manager and ask that the period of labour might be reduced to 54 hours per week. No doubt is entertained that the application will be granted.

Trade of the South Wales Ports.—The foreign exports of coal from Cardiff in October were 231,529 tons, against 163,719 tons in October, 1870; from Newport, 34,620 tons, against 32,528 tons in October, 1870; from Swansea, 60,181 tons, against 36,644 tons in October, 1870; and from Llanelly, 10,641 tons, against 2189 tons in October, 1870. The shipments coastwise of coal from Cardiff in October were 80,197 tons, against 70,923 tons; from Newport 70,728 tons, against 50,263 tons; from Swansea, 15,870 tons, against 19,126 tons; and from Llanelly, 14,404 tons, against 13,163.

Avonmouth Dock Works.—A landslip has occurred at the new dock at Avonmouth which must necessarily delay the works to some extent. The damage actually done is not expected, however, to exceed 700*l.*

Great Western Railway.—The Great Western Railway Company has given notice of its intention to apply to Parliament for powers for the purchase of the Swansea Canal, and for the construction of certain branch lines up the Swansea Valley. The Swansea Valley is considered to contain a large amount of, at present, dormant mineral wealth.

Nantyglo and Blaina Iron Works Company (Limited).—It is announced that Mr. H. Bailey, late of the firm of Messrs. J. and C. Bailey, has joined the Board of the Nantyglo and Blaina Iron Works Company (Limited). Sundry important extensions and improvements are about to be carried out in the establishments of the company.

Great Western Steamship Line.—We understand that Messrs. Mark Whitwell and Son have let a contract for a second steamer for this line. The steamer is being built by Messrs. W. Pile and Co., Sunderland, and she is to be ready for the station in April. Her gross register tonnage will be 1570 tons, and she will be spar-decked. Her engines, which will be on Allen's patent compound principle, are being constructed by the North-Eastern Marine Engineering Company. They will be 700 horse power effective.

Ross and Monmouth Railway.—This line is expected to be completed and to be ready for traffic by the close of next summer. The contractors, Messrs. Firbank and Co., are employing as many labourers as they can obtain.

Labour in Wales.—A few of the leading artisans belonging to Rhymney, Ebbw Vale, Blaina, Blaenavon, Aberaychan, and Pontnewynydd Iron Works have had a special meeting at Brynmawr for the purpose of considering the nine hours system. The meeting strongly supported the new movement, which has become so general.

Crossing the Severn.—There appears to be a prodigious furore just at present for schemes for crossing the Severn. Three of the new projects propose to cross the Severn by bridges at Sharpness, two by high-level bridges from Tidenham and Caldicot respectively to Almondsbury, and the sixth by tunnel at Portskewet. Five at least of these schemes must obviously come to grief.

Tramways in Bristol.—The Bristol Town Council has held a meeting on the subject of laying down tramways in that city. The question discussed was whether the tramways should be laid down by the corporation or by a private company, and after two hours' discussion it was decided, by a majority of 36 to 15, that the work, if undertaken at all, should be undertaken by the corporation.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig Iron Market.—Since this day week there has again been some fluctuation in the price of pig iron in the Glasgow market, but still it cannot be denied that, speaking generally, there is a healthy condition prevailing. On Thursday last prices were up at 69s. and 69s. 1d. cash, and 69d. 6d. one month; towards the close, however, there was a decline. A fair business was done the following day at 68s. to 68s. 4½d. cash, and 68s. 6d. to 68s. 9d. one month. The cash price declined on Monday to 67s. 11d., and the month's price to 68s. 4d., the market closing at somewhat higher prices. There was an improvement yesterday, and to-day's market has been strong with prices up to 68s. 9d. cash and 69s. 1½d. one month, closing sellers at these prices, buyers 1½d. per ton less. The special brands are remaining very firm, Gartsherrie and Coltness No. 1 still at 82s. per ton, and other brands at proportionate rates. After a long succession of large weekly shipments there has at last been a break, the shipments for last week having only amounted to a total of 10,779 tons as against 15,553 tons in the corresponding week of last year. It should be remembered, however, that about this time last year the German ports had just been opened, and that in consequence there was an extraordinary increase of shipments to Fatherland. Scotch iron is very scarce in America, and prices are going up. The public stores in Glasgow are sending out a large amount of pig iron.

Royal Scottish Society of Arts.—The usual meeting of this society was held in Edinburgh on Monday evening, when Dr. Stevenson Macadam, F.R.S.E., read a valuable communication on the relative photogenic value of vegetable, animal, and mineral oils, and coal gas. After giving many interesting details obtained by experimental research, Dr. Macadam said that paraffine oil and gas are cheaper than any of the other materials. Where any reasonable quantity is used, gas is decidedly the cheapest; but where extremely small jets are employed, the ordinary paraffine lamp has the advantage in respect of cost, though it requires some trouble to keep it in order. In concluding his paper, Dr. Macadam called attention to the fact that the refined paraffine oil used in lamps, and which costs 2s. per gallon, is made from crude paraffine oil costing only 4½d. or 5d. per gallon. If, he said, they could get the crude oil broken up into a permanent gas, he did not see why an illu-

minating agent should not be got at a very cheap rate. Mr. Miller said that in Prussia, Silesia, and other parts of the Continent he had seen gas made from the crude paraffine oil, which was said to be not only better than that made from coal but much more economical. Mr. Reid said that something of the kind had been done in this country under Mackenzie's patent by mixing the crude oil with coal dust. The oil had also been used alone in a retort. Great difficulty had, however, been found in getting equal results. Mr. Miller said that on the Continent the practice was to run the crude oil into the retorts, which were kept at an uniform low temperature. Dr. Macadam said there was no difficulty in getting a good gas from the oil, but the difficulty was to get a gas that would keep its quality for more than a day or two. Some further discussion took place, and a vote of thanks was accorded to Dr. Macadam for his paper.

New Handle for Railway Carriage Doors.—Mr. Jones, locomotive superintendent of the Highland Railway, has invented a new handle for carriage doors. Its special advantage is that once the door is shut, and the handle turned, no thoughtless or accidental interference will have the effect of throwing the door open—a thing that sometimes may occur with the common handle. The mechanism is ingenious and simple. On the inner side of the ordinary cross handle there is a small handle or trigger; both are grasped together, the inner handle being pulled out simply by shutting the fingers, and so, when the latch is turned, the door opens. When the door is shut the trigger keeps it like a lock, and the handle cannot possibly be turned unless both handles are grasped for that purpose. A secondary advantage is the absence of stiffness in the latch, as the spring used at present is dispensed with; in fact, the latch is not likely to become either too stiff or too slack. At first sight it seems as if passengers inside the carriage must open the door more slowly than at present, but should this be the case an additional guard will be provided against carelessness, and people will be prevented from hastily opening a door and getting out before the train stops. The absence of stiffness in turning the latch, however, will probably more than counterbalance any little awkwardness in seizing the inner handle from the inside. The design has only yet been applied to one or two carriages.

Greenock Water Trust.—The usual meeting of this trust was held yesterday. The superintendent's report shows that the water in store on the 23rd inst., was 205,944,301 cubic feet. There is a great demand for the water for the public works of the town as a source of power, and in consequence much anxiety is felt for the water at the New Gryffe Works. But this cannot yet be turned on, as it is not sufficiently sweet for domestic use.

The Glasgow Coppersmiths.—A demand has been made by the Glasgow coppersmiths for an advance of wages of 2s. 4½d. on the week of 57 hours, and to be paid weekly instead of fortnightly as at present. The employers have offered an advance of ¼d. per hour, to commence on 1st January next, and have declined to pay weekly wages. A conference is likely to be held at which the masters and men will mutually strive to adjust the matters in dispute. The rate of wages at present paid in the trade varies from 5½d. to 6½d. per hour. Owing to the enormous development of the sugar-machinery business and marine engineering in Glasgow and on the Clyde, this trade has come to assume very large dimensions.

Large Orders in the Boiler-Making Trade.—In connexion with the present state of the boiler-making trade in Glasgow, it may be mentioned that Mr. William Wilson, of the Lilybank Boiler Works, has in hand many heavy orders, including work for Russia, Milan, London, and various other places. He has lately been asked to tender for the boilers of a large steamer now building at Sunderland.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the attendance on 'Change was not so large as on the previous market day. Comparatively little business was done, but there were more buyers than sellers. The fact is that, although the production is increased nearly every week, the demand is so much heavier that iron is scarce. In one case yesterday a parcel of No. 3 was sold at 61s. four months' bill. Nothing less than 60s. for that quality was paid for immediate delivery, and several makers booked orders at that figure for delivery next year. There is a capital local and general demand for all descriptions of pig iron. There is every indication that prices will be fully maintained for some time to come.

The Finished Iron Trade.—Excepting that the demand for rails is better, and that prices generally in the finished iron trade are improving, there is nothing new to report.

Puddling by Machinery.—Last week we stated that it would be a month or two before the commission sent out to America to inquire into Danks's puddling furnace could lay their report before the iron trade of this country. Recently, however, a telegram has been received from the commission, stating that the furnace is a success, and advising the construction of furnaces of 10 cwt. When Mr. Danks read a paper at the last meeting of the Iron and Steel Institute at Dudley, he claimed for his revolving furnace the following advantages: A great saving in the cost of labour, and also in the consumption of coal, varying according to the size of the furnace; a superior and more regular quality of puddled iron from a given quality of pig; a yield of puddled iron much in excess of the charge of pig metal, instead of the usual less, the extra yield being obtained by the reduction of the rich fettling used in the machine; eight to ten heats, whether of from 5 to 10 cwts. are made in a day of ten hours when suitable metal is used; the refining process is very complete, the whole of the phosphorus and silica, and the sulphur to a large extent, being removed by the chemical action of the lining mixture; the very heavy and exhaustive labour of puddling is performed by steam power, thereby enabling one skilled man to attend to the working of a large quantity of iron: the bringing to nature and balling of the iron is completed by the rotary action without the use of rabbling, except when the heat has to be divided into smaller balls; and the capacity may be suited for heats of any weight from 5 cwt. upwards. The cost of the furnace, weight of product considered, is about the same as that of the usual hand-puddling furnaces. We understand that Mr. Danks will charge as royalty 2s. per ton. It is very probable that some of Danks' furnaces will be built without further delay.

More Ironstone Discovered in the Cleveland District.—At Kirkleatham, near Redcar, on the estate of Mr. Newcomen, a seam of ironstone about 9 ft. thick has been discovered.

Iron Shipbuilding.—On the Tyne every yard is as busy as possible. There is plenty of work on the Wear, and the builders on the Tees are full of orders. On the latter river Messrs. Backhouse and Dixon, of Middlesbrough, are exceedingly busy.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Completion of the Halifax and Ovenden Junction Railway.—The joint committees of the Great Northern and Lancashire and Yorkshire Railways have resolved to proceed at once with the construction of this short line. It is about two and a half miles in length, commences near the Halifax passenger station, passes through that town, and terminates at Holme Field Mills, in the parish of Ovenden. The engineer to the scheme is Mr. John Fraser. There will be one viaduct of 41 or 42 arches, a tunnel of about 250 yards in length, and some tolerably heavy cuttings.

Railway Improvements in South Yorkshire.—I am informed that the Manchester, Sheffield, and Lincolnshire Railway Co. have found it necessary to lay down an additional line of rails on the south side of their Sheffield station for a considerable distance, in fact, nearly as far as Woodburn Junction, where the South Yorkshire branch joins their main line. This step is rendered necessary by the very large and ever increasing passenger and goods traffic which passes over this part of their system. It is also stated, on good authority, that the same company contemplate the purchase of several lots of property, at Sheffield, for the construction of more sidings. They are also extending their accommodation at Rotherham and other South Yorkshire stations. The Midland Railway Company are about to make some alterations at Leeds, among which will be the widening of the Nineveh-lane Bridge over their lines.

The Nine Hours' Movement at Halifax.—On Thursday evening last a meeting (convened by the Nine Hours' League) of mechanics, blacksmiths, machine-joiners, &c., was held in the Temperance Hall, Halifax, for the purpose of receiving reports from the representatives of various factories in reference to the applications made to the employers for the concession of the nine hours. Mr. R. Craven, president of the Halifax league, occupied the chair. A number of reports was made by various representatives as to the disposition of the employers with respect to the movement, but none of them were deemed satisfactory. Messrs. Crossley and Sons, and Messrs. Whitely and Sons were in favour of 54 hours per week at 27s., overtime to be 6d. per hour. A resolution was passed disapproving of any terms other than the nine hours per day pure and simple. During this week a strike has happily been averted at Sheffield. Two men (engineers) in the employ of Messrs. Davy Brothers, Sheffield, could not agree with their employers as to the manner in which the 54 hours should be worked. On Saturday last they sent Messrs. Davy a circular in which it was stated that unless a notice was posted before 5.30 p.m. on Monday, agreeing to the propositions of the men, they would strike. Fortunately some modifications were made on both sides and the dispute was prevented.

Great Failure at Sheffield.—A meeting of the principal creditors of Messrs. Charles and Co., of Millsands Forge, and Kelham Forge and Rolling Mills, Sheffield, was held in the Cutlers' Hall in that town on Thursday last. About seventy creditors (or persons representing creditors, &c.) were present. It was stated that, as far as could be ascertained, the liabilities of the firm exceeded 200,000*l.*, but it was hoped that by means of an advance, and by the postponement by the creditors of their demands for a short time, to obviate the necessity of Messrs. Charles suspending payment. The meeting was, I am informed, somewhat noisy and dissonant, and lasted for about three hours. On Saturday Messrs. Charles, in consequence of their being threatened with bankruptcy proceedings, filed a petition for liquidation by arrangement. Mr. Alfred Allott, public accountant, &c., has been appointed receiver and manager. It is stated that the pecuniary difficulties are attributed to the expenditure of large sums in improvements and additions to the mills and premises in Millsands, Sheffield.

Newark, Melton Mowbray, and Leicester Proposed Railways.—Notice is given of an intended application to Parliament by the promoters of the Newark, Melton Mowbray, and Leicester Railways, under the auspices of the Great Northern. The proposed line is to leave the Great Northern at Newark, and proceed to within a short distance of Bottesford on the Great Northern, Grantham, and Nottingham branch. It then goes forward to Melton Mowbray, and thence to Leicester. There are to be connecting branches east and west at Bottesford, a branch to Waltham, Leicestershire, and branches to the Midland at Melton Mowbray and at Leicester. Whether this scheme will pass or not seems exceedingly doubtful.

A NEW RUSSIAN PORT.—The Russian Government have granted a concession for the construction of a railway between St. Petersburg and the mouth of the Neva, where a great commercial port, with docks and warehouses, is to be made.

FOREIGN AND COLONIAL NOTES.

International Telegraphic Conference.—At this Conference, to be held in Rome early in December, Turkey will be represented by Izzet Effendi, inspector-general of Turkish telegraphs, and Yoneo Effendi, one of the superior officials of the department.

Turkish Ordnance.—The Grand Vizier in company with the Seraskier Pasha has paid a visit to the Turkish arsenal, at Tophanch. He also went over the gun factories and minutely inspected various guns in process of manufacture, expressing his satisfaction with what he witnessed.

San Francisco Bay.—It has been proposed to bridge the bay at San Francisco 7 miles wide, and thus shorten the distance from San Francisco to Sacramento by one half or about 100 miles. The project has at present, however, only reached a very imperfect stage of development.

Rails for Spain.—The Monceau-sur-Sambre Iron Works Company has obtained a contract for 6000 tons of rails about to be used in the construction of the Medina del Campo and Salamanca Railway. The length of the new line will be 48 miles.

The Moerdyck Bridge.—This splendid work will be ready for traffic, it is expected, early next year. There will then only remain the Rotterdam bridge or viaduct to be carried out to establish the direct communication which has been long desired between Amsterdam and Brussels.

A New Steam Line.—The Tenasserim (s.s.), the first of a line of steamers which is to run regularly between Glasgow and Rangoon, has arrived out. She is a large and powerful vessel and she came out to India *vid* the Suez Canal. Along with a valuable general cargo the Tenasserim brought out in pieces a new steamer for the Irrawaddy Flotilla and Burmese Steam Navigation Company, which will be put up at Dallah and which will, it is expected, be ready for service by the close of the year. This new river boat is to be named the Alompra, and she is guaranteed to attain a high rate of speed.

Central Pacific Railroad.—The annexed return shows the weight of through freight passing over the Central Pacific division of the Pacific Railroad during the first nine months of this year: January, 1,521,988 lb.; February, 1,562,248 lb.; March, 2,744,246 lb.; April, 4,913,071 lb.; May, 7,268,441 lb.; June, 5,701,709 lb.; July, 3,975,788 lb.; August, 5,158,662 lb.; September, 3,907,607 lb. The traffic for September was 1,600,000 lb. larger than in any previous month this year.

Progress in Brazil.—The Union Industrial Company with a capital of 40,000*l.* has been formed with the view of assisting in the improvements and steam navigation of the Campos and Macahé canal, and maintaining a line of steamers between Macahé and Rio de Janeiro. It is also proposed to aid in establishing a factory of turf fuel near the canal.

Road Steamers in Brazil.—The Vice-President of Bahia has promised a subsidy of 800*l.* for a Thomson road steamer from Alagoénhas to Jacu.

Gas in Paris.—The revenue of the Parisian Company for lighting and heating by gas has not quite regained its old importance. The receipts of the company in October were 122,918*l.*, as compared with 139,091*l.* in October, 1860. It would be almost useless of course to attempt a comparison with October, 1870.

Brazilian Rivers.—The exploration of the Rio Xingu has been effected for 140 miles up stream, or as far as the lowest rapids. These are believed to be practicable, but had not actually been passed by the exploring steamer. The stream is reported to have been found, as a rule, to be five miles in width and nearly a mile at the narrowest point.

Sewage of Buenos Ayres.—Mr. Bateman has been consulted upon the sewage of Buenos Ayres, and it is understood that he has written from London to Señor Aguirre to the effect that a metal tube 5 ft. in diameter laid along the Riachuelo to the shores of the river Plate between Barracas and Quilmes will be sufficient to carry off the sewage. But as the casting of such a tube would be extremely costly, he recommends instead the use of two tubes, each 3½ ft. in diameter through which the sewage could be forced by means of a steam engine of moderate power. The cost of the works thus proposed is estimated at 80,000*l.*

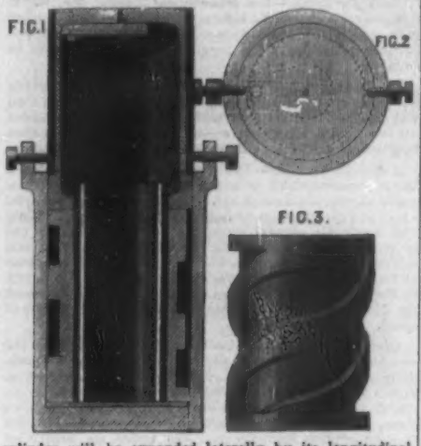
Canadian Enterprise.—A new railway project has been started in Montreal, which may be attended with important results to that city. Sir Hugh Allan, of the Allan Steamship Company, has been appointed president of a company to build a Northern Colonisation Railroad running from Montreal to Ottawa, where it is to connect with the Canada Central Railway at Pembroke. Thence a line of 160 miles is to reach Lake Nipissing and there to connect with the network of lines in connexion with the Northern Pacific Railroad already in course of construction. A bridge is to be thrown across the St. Lawrence at the island of St. Helen's.

Subsidies for American Ocean Steamers.—The New York Chamber of Commerce recently had under consideration an application to express an opinion in favour of money subsidies from the United States Congress in support of the recently established line of steamers from San Francisco, California, to Melbourne, Australia. A committee appointed to examine the question reported that in the present condition of the national finances and with the prospect that some measures may be required to revive the general shipping interests of the United States, it was inexpedient to endorse an application to congress to grant the proposed subsidies for the line of steamers to Australia. After a long and animated discussion, however, it was finally resolved to refer the report back to the committee with instructions to prepare a resolution in favour of a liberal subsidy to the San Francisco and Melbourne steamers.

RECENT PATENTS.

The following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 3290, 8d.) William Robert Lake, of Southampton-buildings, patents, as the agent of Patrick Sarsfield Devlan, of New Jersey, and Isaac P. Wendell, and Stephen P. M. Tasker, of Philadelphia, U.S., arrangements of bearing and buffer springs for railway vehicles, &c. In these springs a hollow cylinder (or cylinders) of india-rubber is combined with a metallic case and plunger in such a manner that the compression of the spring is resisted by the joint action of the india-rubber and the air contained in its cavity. The annexed sketches Figs 1 and 2, show one arrangement of this spring, while Fig. 3 shows the india-rubber cylinder removed from its case. It will be seen that the india-rubber



cylinder will be expanded laterally by its longitudinal compression, and the lateral expansion serves to prevent the escape of air. The plunger is, however, fitted with a valve opening inwards for the purpose of admitting air to the interior of the cylinder to make up any loss due to leakage.

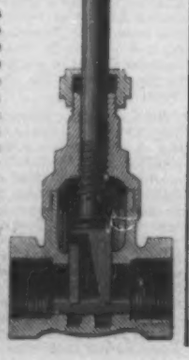
(No. 3292, 1s. 4d.) John Donald, of Glasgow, patents, as the agent of Carl Wittenström, of Motala, Sweden, arrangements of furnaces in which the fire is fed either continuously or at very brief intervals with fuel broken into small pieces and introduced through a hopper situated in the firebox crown. Arrangements are provided for admitting air around this hopper as well as through the fire-grate in the ordinary way. The patent includes the application of these plans to furnaces of various kinds and to steam boilers.

(No. 3295, 1s. 4d.) Julius Frederick Moore Pollock, of Leopold-street, Leeds, patents several arrangements of machinery for pulverising or crushing cement and other substances. We cannot describe these plans briefly.

(No. 3297, 8d.) Robert Baird, of Greenock, patents arrangements of punching and shearing apparatus in which the pressure is so applied by the action of cams rolling on each other, that it is the greatest at the commencement of the action of the punch when the latter has to encounter the resistance due to the whole thickness of the plate. The patent includes a variety of forms of apparatus.

(No. 3300, 4d.) John Moore Hyde, of Greenwich, patents armour-plating ships, &c., with steel plates having their external surfaces hardened or tempered, these plates being either used separately or in continuation with iron plates. We greatly doubt whether the hardening of the external surface of the plates would have any beneficial effect, and it would certainly be difficult to carry out in practice.

(No. 3304, 8d.) Sydney Smith, of Hyson Green Brass Works, Nottingham, patents the form of valve shown by the annexed sketch. It will be seen by the latter that in this arrangement the passage is closed by a valve which is tightened up against its seat by a wedge piece at the back. The stem of the valve enters an elongated hole in this wedge piece, so that in opening the valve the wedge piece is first raised by the screw so as to release the valve, the valve and wedge piece subsequently rising together. On the other hand, in closing, the valve and wedge piece descend together until the former is opposite its face, when it stops and the wedge piece, being forced down further by the screw, tightens it up.



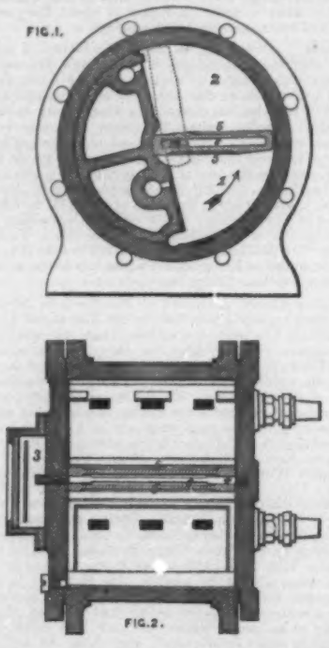
(No. 3306, 1s.) James Lamb Hancock, of Ley Hill, Sutton Coldfield, patents the simple machine for skinning potatoes described by us in our account of the Royal Agricultural Show in July last. *Vide* page 44 of the present volume.

(No. 3316, 1s. 2d.) Edward Foulger, of Liverpool, patents arrangements of permanent way for tramways, his plans including the use of rails having two or more parallel grooves in their heads so as to enable them to form a compound track. The patent also embraces modes of utilising this compound track at points when two or more lines of tramway branch off or cross each other.

(No. 3318, 10d.) Albert Marcius Silber, of Wood-street, Cheapside, and Frederick White, of Camberwell, patent arrangements of roof lamps for railway carriages, these lamps being specially adapted for burning petroleum and other mineral oils. It is probable that we may illustrate one of these lamps shortly.

(No. 3322, 1s. 2d.) John Hargrave, of Heaton Norris, patents an arrangement of railway signal intended to be set to danger by the passage of a train or engine past a given point, and kept in that position until the said engine or train has reached some point in advance. The whole apparatus would probably come to grief the first time it was acted upon by a train passing it at a high speed, but Mr. Hargrave may have the consolation that in this respect, as well as in many others, it does not differ materially from some dozens of plans which have been proposed by previous patentees.

(No. 3328, 8d.) John Reid, of Leith, patents an ingenious form of fluid meter, the general arrangement of which will



be understood from the annexed diagrams. From these, it will be seen that the measuring chamber is a segmental cylindrical provided with a radial piston capable of sliding diametrically through its axis. The fluid to be measured enters at the lower openings shown, and forces the piston round until it arrives in the position shown by dotted lines, when the piston drops diametrically through its axis and assumes a position similar to that which it occupied at the commencement of the "stroke." This sliding movement of the piston uncovers the opening for the escape of the fluid which has been measured. It will be seen from what we have stated, that the piston turns on each of its opposite edges alternately, its semi-revolutions being alternated with the sliding movement already referred to. We have heard a good account of the performance of this meter.

(No. 3328, 4d.) Jacob Geoghegan Willans, of 9, St. Stephen's-crescent, Paddington, patents modes of burning powdered fuel. Mr. Willans claims constructing "furnaces in such a manner that a blast or current of air in which fuel is held suspended is caused to pass to the chamber or place where the heat is to be used through, underneath, and amongst coke or other open fuel contained in a fire chamber, such fire chamber being closed at the bottom, excepting an aperture for the escape of slag." The patent also includes the use of sieves for distributing the powdered fuel, and the combination of turbines with the fuel feeding apparatus for the purpose of enabling the latter to be worked with great regularity.

(No. 3332, 10d.) Walter Williams, of Wednesbury Oak, Tipton, patents, as a communication from Robert Briggs, of Philadelphia, U.S., an arrangement of rotary shearing machine which we intend to illustrate shortly, and which, therefore, we need not describe here.

(No. 3333, 1s. 4d.) William Firth, of Leeds, patents a machine for dressing cannel coal or other minerals. In this machine the dressing is performed by a suitable cutting blade which is moved up and down in suitable guides by being attached direct to the piston rod of an overhead steam cylinder.

(No. 3337, 1s. 2d.) Andrew Howatson, of Manchline, patents an arrangement of puddling furnace to which reference has been several times made in our pages. We shall probably describe this furnace fully at some future time.

(No. 3346, 4d.) Henry Young Darracott Scott, of Ealing, patents improvements in the processes for manufacturing selenitic mortars and cements. General Scott's plans have already been noticed in this journal.

AMERICAN RAILWAY STATISTICS.

From Poor's recently published "Railroad Manual" we deduce some interesting statistics.

It will be found that, commencing from the year 1841, at which time there were 3535 miles of railroad, until 1848, the yearly increase was about 300 miles. From 1848 to 1856 there was a yearly increase of 1700 miles; then for two years at the rate of 2400 miles; and from that date a gradual diminution till the minimum yearly mileage was reached in 1861. From that date there was a gradual increase until the close of the war in 1865, when so great an activity was shown that while in 1865 the increase was 3000 miles per annum, we find it last year to be 6000 miles.

There are something like 1300 to 1400 railroads projected, in progress, and completed, and the number is rapidly increasing.

As illustrating the variety of gauges and the number of each kind, we have compiled the following Table, which shows the differences of practice in this country:

Gauge. ft.	in.	No. of Railroads.
3	0	2
3	6	2
4	3	1
4	3½	1
4	5½	1
4	6	6
4	8	3
4	8½	307
4	8¾	2
4	9	13
4	9½	3
4	9¾	1
4	9¼	7
4	9½	1
4	10	30
5	0	74
5	2½	1
5	9	1
6	0	31

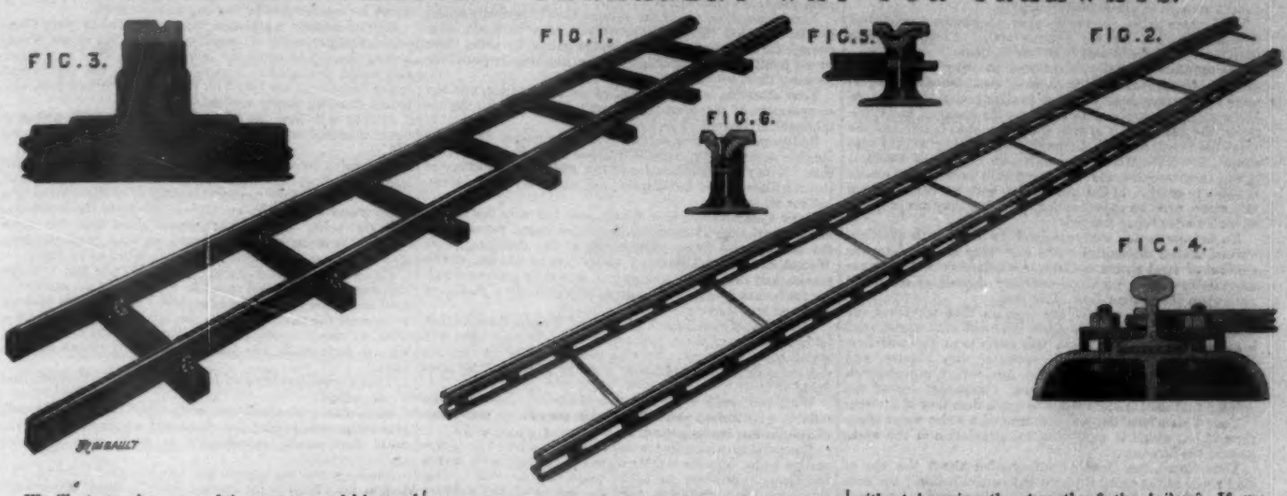
We find by examination that there are upwards of 10,000 locomotives and about 214,000 cars of all kinds, which makes a ratio of 1 locomotive to 20 cars. It must be recollected, however, that coal companies using a great number of cars (and those mostly 4-wheeled) with comparatively few locomotives increase this ratio, while only a few smaller roads, constructed through mountainous country, require greater locomotive power in proportion to the amount carried. Allowing 30 ft. only as the length of a car, we would have, if all the cars were connected in one line, a train extending from New York to the Mississippi River; while, allowing 50 ft. as the length of engine and tender, there would be a line of locomotives 100 miles long. The total mileage of railroads was 53,399 at the beginning of 1871. Illinois comes first in the total length of its roads; Pennsylvania follows closely, then some in order New York, Ohio, Indiana, and scattering along all the other states and territories, concluding with Rhode Island, with 196 miles.—*Chicago Railroad Gazette.*

Panama Railroad.—Mr. David Hoadley, who, for the last 18 years has been president of the Panama Railroad Company, having retired from the office, the directors have unanimously elected as his successor, Mr. Joseph F. Joy, who has hitherto been vice-president and secretary. Mr. J. Keeler will be the new secretary of the company. Mr. Hoadley remains a member of the Board of Directors.

Canadian Telegraphy.—In 1869 an Act was passed incorporating the Canadian and European Telegraph Company for the purpose of establishing telegraphic communication between the continents of Europe and North America, *viâ* the Straits of Belleisle and Anticosti, or Labrador Coast to Greenland, Iceland, the Faroe Islands, and Scotland. It is stated that there is now some prospect of the project being revived. The question will, it is even hinted, be mooted at the International Telegraph Conference about to be held at Rome. The Dominion Telegraph Company is increasing its appliances in order to meet its increasing business.

Russian Steam Navigation.—The Russian Steam Navigation, Trading, and Odessa Railway Company have recently ordered three steamers of Messrs. Samuda, Brothers, three steamers or Messrs. J. and W. Dudgeon, and three steamers of the Thames Iron Works. Besides these they have at present building by Messrs. Samuda, Brothers, one large steamer for their home trade and one by Messrs. Leslie, of Gateshead, for their China line, so that their fleet will exceed 80 steamers. The company have also belonging to them about 700 miles of railway extending from Odessa northwards and towards the Austrian frontier. Their steamer Nachimoff, which made the first voyage to Bombay, is now preparing to leave England for a second passage to that port.

CROSS AND LARSEN'S PERMANENT WAY FOR TRAMWAYS.

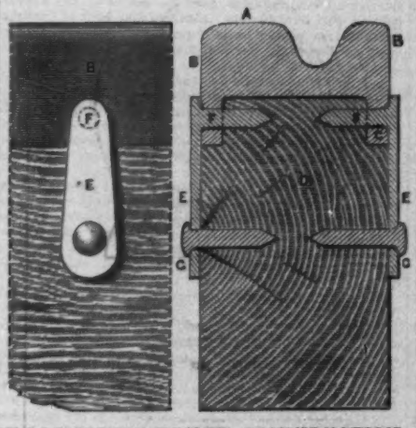


WE illustrate, above, one of the most successful forms of permanent way for tram roads, which has yet been introduced, and which is giving great satisfaction in those parts of the metropolis where it has been extensively laid down, and exposed to the action of very heavy traffic, as, for instance, at Camberwell, Walworth-road, New Kent-road, Westminster Bridge-road, &c. The construction of the permanent way, which has been designed by Mr. J. D. Larsen, of Tramway Wharf, Greenwich-road, will be understood from the engravings. From the perspective view, Fig. 1, it will be seen that the permanent way consists of cross sleepers laid at short intervals, and supporting longitudinal sleepers connected to them by angle brackets spiked to both. The rail which rests upon the top of the longitudinal sleepers is rolled with flanges on each side, as shown, which are deep enough to receive one end of a strap, or half staple, the form of which is shown in the enlarged sections. The upper end of this half staple is provided with a spike which passes through a corresponding hole in the flange of the rail, whilst the lower end has a hole through which a separate spike is driven into the longitudinal sleeper. With these fastenings, which are placed at short intervals, the rail cannot become loose from the sleeper, and one of the great difficulties so common in tramway maintenance is avoided, in addition to which a much better and more convenient fastening is obtained than that in which vertical holes are drilled through the rail at the bottom of the groove, and screws are passed through to attach it to the sleeper. Another advantage of Mr. Larsen's method is that there can be no percolation of water through the holes of the rail to the sleepers, which are thus preserved from injury.

IN the engravings are also shown two other forms of permanent way, Figs. 2, 5, 6, designed by Messrs. Cross and Larsen, and which, being wholly of iron, are especially adapted for tropical climates. The longitudinal sleeper is in effect a light cast-iron girder, with a large proportion of the web cut away for reducing the weight, and by the combination adopted, an extreme lightness is obtained, the whole of the permanent way weighing only 62 lb. per yard.

The necessary degree of elasticity is secured by placing a layer of felt, or similar material between the steel rail and the sleeper, and this medium is also an effectual preventive against crystallisation, which would otherwise destroy the cast-iron sleeper. The mode of securing the rail is shown in the section, where it will be seen that the rails and sleeper are drilled at intervals with vertical holes which enter a recess formed in the under side of the upper flange of the sleeper; screws with grooved heads are passed through these holes, and engage in nuts which are placed loose in the recesses alluded to. By this means whenever it is necessary to replace a rail, the operation can be performed without disturbing the surface of the road, on either side of the rail, which is no small advantage. It is claimed also for this arrangement that it is especially suitable for asphalte laid roads, on which the last advantage named will be fully appreciated. Fig. 4 is a section of a light form of permanent way for railroads, with a continuous longitudinal sleeper, which is also shown in the engraving.

RANSOME'S ARTIFICIAL STONE COMPANY.—The gold medal was lately awarded to the Pacific Stone Company, established at San Francisco, for the samples of Ransome's artificial stone manufactured by them, and exhibited at the San Francisco State Fair. We are glad to notice the practical and commercial success which has attended this company since Doctor May came over to this country some two years since, as its representative, to learn direct from Mr. Ransome the details of the process he had been unable to acquire. Since his return and the arrival of Mr. E. Ransome in San Francisco, the works of the company have become eminently successful.



LOCOMOTIVE BOILER CONSTRUCTION.

THE fourth annual meeting of the American Railway Master Mechanics' Association, was held at Louisville on the 12th of September last. After an opening address from the President, Mr. H. M. Britton, the treasurer's report was read, and various new members were elected. A report of a Committee on Boilers, Boiler Materials, and Soft Steel Rivets, was then presented, and read by the secretary, Mr. L. P. Dodge. The report is as follows:

Your attention is invited to the fact, that as this is their third report upon the first-mentioned subject, it is difficult to avoid going over portions of the ground covered by previous reports. Your indulgence is asked for any such repetition.

A copy of the following questions was sent to each master mechanic in the country, and answers thereto solicited:

1. Do steel boiler plates, as now manufactured, have the proper degree of hardness, or should they be softer and more ductile?

2. Do you advise the substitution of steel plates for iron, for the outside shell of locomotive boilers?

3. Are steel flue sheets more apt to crack, from frequent caulking, than those made of the best Low Moor iron?

4. Are steel furnace sheets, especially crown and flue sheets, with the ordinary deposit of scale and mud upon them, more liable to fail than the best Low Moor iron?

5. Have you used a wider water space than 3½ in.? If yes, do you deem it advantageous?

6. Have you used soft steel rivets in the construction of locomotive boilers? If yes, do you prefer them to iron?

7. Has your experience during the last two years suggested any desirable changes in the construction or heating of locomotive boilers?

8. If manufacturers will furnish the material of the required size, would you advise making the cylinder part of the boiler *in one sheet*, extending from smokebox to throat-sheets?

9. Have you used steel flues in locomotive boilers? If yes, do you prefer them to iron and copper?

10. At what point in a locomotive boiler should the feed-water be injected?

11. The furnace as now constructed, with the crown bars resting on its corners, sustains on its sides the pressure on the crown sheet, except where relieved by the braces extending from the crown bars to the outside shell, the circulation of water is impeded by the bars, and the washers placed between them and the crown sheet. The scale formed on the braces falls on the crown sheet, and with that deposited thereon increases the liability of the sheet to fail. Can you suggest a plan which will avoid these difficulties without lessening the strength of the boilers? If yes, please do so.

Although four hundred circulars were sent, only twenty-three answers were received, principally from important roads.

To the first question, a number of the replies state that steel plates, as now manufactured, are too hard, and as they harden by use as furnace sheets, they are liable to crack. On the Illinois Central Railroad four steel furnace sheets have cracked. One was a back flue sheet, and three were side sheets. These were in all probability hard when manufactured, and the hardness increased with use until they became too brittle to withstand the strains caused by unequal expansion and contraction.

On the Chicago and North-Western Railroad a side sheet, of a steel furnace, cracked while the engine was standing in the engine-house, and while the men were cutting it out, the other side sheet also cracked. It is probable that "blowing off" the boiler, and while hot filling it with cold water, produced unequal contraction, resulting in the failure of the first sheet. Cutting that one out jarred the other while subject to an undue strain, whereupon it also failed.

Sometimes a sheet will be found too hard to be worked into shape as readily as is desirable, but your Committee are of the opinion that, in proportion to the number used, no more steel sheets fail on account of being too hard than do iron sheets on account of lamination, blisters, &c., which faults are peculiar to them alone, and are not found in steel sheets.

Reliable boiler material is a necessity, and railway managers look to the manufacturers for it. A removal of all liability to accident on account of excessive hardness, or any other fault in manufacturing, must be obtained. Defective boiler-plate can be avoided only by continued care and watchfulness on the part of the manufacturers.

Your Committee, therefore, urge the propriety of requiring them to give special attention to the ductility and homogeneousness of steel furnace sheets.

In answering the second question very few favour the substitution of steel for iron for the outside shell of locomotive boilers. It is not probable that such change will be made so long as the difference in cost is so largely in favour of iron, and the difference in tensile strength not greatly in favour of steel.

Steel sheets, soft enough to be flanged and worked to shape, are not enough stronger than the best iron to warrant any marked decrease in thickness. Such boiler-sheets as are not flanged might be made harder, and, consequently, stronger than the others, and perhaps a slight reduction might be made in their thickness without making their total strength less than the softer and thicker sheets; but the saving in weight would be too small to justify this departure from a uniform thickness in the outside shell of a boiler, which, if made, might result in the thinner and harder sheets cracking along the rivet seams, from unequal strains due to expansion and contraction. During the last month your Committee experimented upon the tensile strength of steel, with a view to giving you its breaking strain per square inch of section.

Three pieces of $\frac{7}{16}$ steel plate, ductile and homogeneous, were prepared and torn asunder by hydraulic pressure. The results were as follows:

No. 1—Broke under a strain of	77,864	lbs.	per	sq.	in.	of section.
No. 2— " " "	71,586	"	"	"	"	
No. 3— " " "	64,051	"	"	"	"	
Making the average	71,167	"	"	"	"	

No. 1 stretched but little, and was very slightly narrowed at the fracture. No. 2 being softer, stretched rather more than No. 1, and No. 3 more than No. 2.

Mr. Hayes, of your Committee, has at different times tested the tensile strength of $\frac{7}{16}$ iron boiler-plate, cut from old boilers, and has found the breaking strain to range from 60,566 lb. to 72,025 lb. per square inch of section.

The iron now used in the waist, or cylinder part of the boiler, can be purchased for one-half the price per pound of steel plate, and the iron for back and throat sheets, domes, &c., for 60 per cent. of the price paid for steel. This iron

will have at least 90 per cent. of the strength of steel made ductile enough to allow ready working.

For furnace plates, however, your Committee prefer steel to iron or copper, for the reasons stated at length in their reports to your second and third conventions.

The opinion generally, expressed in reply to the third question of your Committee, is that steel flue sheets are no more apt to crack from frequent caulking than the best Low Moor iron flue sheets, with the same thickness of metal between the flues. This is true when the steel is soft and the sheet has been annealed thoroughly after being worked into shape; but if there is any considerable degree of hardness it will increase when the sheet is put in service, and render it liable to crack. If the sheets are soft no trouble from this cause need be apprehended, provided they are properly annealed after being flanged.

No definite replies were obtained to the fourth question. Several master mechanics state that they are watching the conduct of steel sheets to discover whether or not they are more liable to fail, with the ordinary deposit of scale and mud upon them, than Low Moor iron.

Your Committee are of the opinion that whenever the water is good, and the deposit of scale and mud slight, steel is no more liable to fail from this cause than the best Low Moor plate. But where the water is very impure, and heavy accumulations of scale and mud occur, especially on the crown sheet of furnace, your Committee are of the opinion that steel is more liable to crack than Low Moor iron.

Your Committee do not recommend a wider water space than 3½ in., which is ample for free circulation of the water around the furnace.

Your Committee have no information about the use of steel rivets in the construction of locomotive boilers; nor have they any knowledge of steel rivets being used by railway master mechanics for the purpose specified. The general answer returned to this question is: "I have never used steel rivets." Under these circumstances your Committee see no reason for recommending a change, but advise further investigation.

No changes in the general form or bracing of locomotive boilers are suggested in the communications addressed to your Committee. Mr. Johann, of the Missouri Pacific road, sent a very complete drawing of a passenger locomotive boiler built by him. The manner of bracing the different parts is clearly shown. A mud drum is attached to the forward part of bottom of waist. Lap-welded joints are used, and the furnace sheets are steel. The drawing is submitted herewith.

Mr. Robinson, of the Great Western Railway of Canada, states that in staying crown sheets he uses 5×¾ bars placed longitudinally, and supported by hanging links secured to T iron, inverted to the outer shell for firebox; from 1½ to 3 in. is the space he allows between the crown bars and crown sheets, and a washer is placed around each crown bolt, as is the usual custom.

One of your Committee, Mr. Hayes, of the Illinois Central Railroad, submits a plan for staying crown sheets of furnaces, a drawing of which accompanies this report. The crown bars do not rest upon the furnace, but upon an angle iron rivetted to outer shell of boiler. An inch bolt is tapped through the outer shell into each end of the crown bars and rivetted over, by which means a row of tie rods is dispensed with. The bars are placed 1½ in. above the crown sheet, and are made of 5×½ iron. No washers are used around the crown bolts, and between the box and sheet, consequently the entire surface of the crown sheet is exposed to the water. Each alternate bar is supported by two vertical braces, secured to the wagon top or outer shell of firebox. When the furnace is taken out the crown bars and their braces are not disturbed. Mr. Hayes states that he has this plan in six new locomotive boilers on the Illinois Central Railroad, and that they carry their water better than when the circulation is more restricted.

Your Committee see no reason for changing their views regarding the system of stays, recommended by them two years ago, for staying the upper parts of front flue sheet and back sheet of boiler. In this connexion your attention is invited to experiments made by your Committee on the comparative strength of stay bolts in iron and steel sheets.

Each end of ½ in. stay bolts, 3½ in. long, cut with twelve threads to the inch, was tapped in a piece ⅞ in. boiler plate, and rivetted over in the usual manner.

The same was done with ½ in. stay bolts and ½ in. steel plate. By hydraulic pressure the plates were then torn from the stay bolts, with the following result, three trials of each being made:

	lb.
No. 1—Stay bolt tapped in $\frac{7}{10}$ in. iron, stripped under a pressure of	22,971
No. 2—Stay bolt tapped in $\frac{7}{10}$ in. iron, stripped under a pressure of	20,914
No. 3—Stay bolts tapped in $\frac{7}{10}$ in. iron, stripped under a pressure of	20,517
No. 1—Stay bolt tapped in ½ in. steel, stripped under a pressure of	18,857
No. 2—Stay bolt tapped in ½ in. steel, stripped under a pressure of	22,286
No. 3—Stay bolt tapped in ½ in. steel, stripped under a pressure of	21,257
Average for stay bolts tapped in $\frac{7}{10}$ in. iron	21,436
Average for stay bolts tapped in ½ in. steel	20,800

In each case the thread on the stay bolt stripped, and the outer edge of the rivet head was sheared off the bolt in pulling it through the sheet.

They are herewith submitted for your inspection.

With two or three exceptions all the communications addressed to your Committee by master mechanics favour making the cylinder part of the boiler in one sheet, extending from smokebox to throat sheets, provided manufacturers will furnish sheets of the required size equal in quality to the best boiler plate, and uniform throughout. If the cylinder part can be made in this way it will have but one seam—a longitudinal one—which may be placed above the water line. An objection to such large sheets is that railway companies do not have rollers long enough to form such sheets into cylinders.

Your Committee are of the opinion that if perfectly sound sheets, of equal thickness throughout, can be made wide enough for the cylinder, the advantage gained by using them would justify the construction of the machine required for forming them into shape.

Your attention is earnestly called to this matter, and the co-operation of manufacturers should be invited for the attainment of the object in view.

Boilers made in this manner will be stronger and more durable without any material increase in cost of construction. Every means conducive to the strength and safety of steam boilers should be adopted, not alone for locomotives, but for all engines.

Your Committee do not favour, and but very few of the master mechanics from whom they have heard recommend, the use of steel flues. Mr. Boon, of the Pittsburg, Fort Wayne, and Chicago Railroad, states that he has ten sets in service, and that he is "well pleased with their performance." As yet he has made no comparison of the relative merits of steel and iron flues.

Mr. Ham, of the New York Central Railroad, writes that he has used steel flues, but prefers iron, because they will stand more caulking. He also states that he can see no difference in the evaporation of water in boilers having flues made of iron.

With testimony so different in character, from equally reliable gentlemen, your Committee can do no more than advise further investigation.

The point at which feed-water should be injected in a locomotive boiler depends largely upon the arrangements of the machinery. Perhaps no better place can be found, considering all circumstances, than the centre of the waist or cylinder part of the boiler, about two feet back of the front flue sheet; a piece of iron, formed to the required shape, being rivetted to the inside of the shell to carry the water to the lower part of the boiler.

The facts stated in the last question of your Committee's circular are well known and freely acknowledged by railway master mechanics. The remedies are not so apparent. In the communications we have received there are no suggestions looking to the mitigation of the evils enumerated, but several gentlemen state that they are giving the matter earnest thought.

The troubles specified are literally forced upon the attention of master mechanics connected with roads whereon the use of impure water is a necessity. Where the water is free from impurities, and slight deposits of scale and mud are made, free circulation over the crown sheet is not of so vital importance, but under any circumstances it should be obtained.

Your Committee present herewith two specimens of scale from a locomotive boiler, stayed in the usual manner, on the Illinois Central Railroad. Each piece was formed on the side of a crown bar, and dropped on the crown sheet, after which another slight deposit formed all over it. On the side of one specimen will be noticed a circular depression, caused by a tie rod between the crown bars. The average thickness of each piece is about three-fourths of an inch.

It is probable that a crown sheet, stayed in the usual way, and covered with such accumulation of scale, would fail before doing half the service obtainable, if free circulation of water is permitted, and no deposits formed.

Your Committee are of the opinion that three errors in the present method of staying crown sheets should be removed.

1st. Resting the crown bars upon the corners of the furnace, thereby making it self-sustaining, except where relieved by the braces extending from the crown bars to the outside shell of the boiler.

2nd. Preventing free circulation of water, by placing the bars too close to the sheet and putting washers around the crown bolts between the bar and sheet.

3rd. Multiplicity of braces and tie rods over the crown sheet.

We suggest the following remedies for your consideration:

1st. To support the crown bars entirely from the outside shell of the boiler.

2nd. To increase the space between the crown bars and crown sheet, and abandon the use of washers around the crown bolts.

3rd. To make the crown bars heavy enough to warrant a decrease in the number of braces over the crown sheet, without impairing the strength of the boiler.

4th. If practicable, to purify the water before it enters the boiler; if this is impracticable, put plugs in suitable positions in the outside shell even with the crown sheet, which plugs should be frequently removed and the crown sheet cleaned as thoroughly as possible.

The area of crown sheet usually covered by washers placed around the crown bolts is surprising to those who have given the matter no serious thought. The furnace of a heavy coal-burning freight locomotive is about 5 ft. long and 40 in. wide at the upper part.

About one hundred crown bolts are used in staying the crown sheet, and they are about 2½ in. diameter. The area of sheet covered by them is 2½ square feet, from which should be deducted the area of the bolts. After making the deduction, we find that 2½ square feet of the crown sheet is kept from the water but exposed to the greatest heat in the furnace, the free circulation of water over the crown sheet is stopped, and the accumulation of mud and scale invited.

No further reason is deemed necessary for urging their abandonment. A little more care is required in putting in the crown bolts without the washers than when the latter are used.

Your attention is invited to the suggestion of purifying the water before it enters the boilers, so that the impurities may not be deposited on the furnace and flues. In alluding to this we know we are touching upon what appropriately belongs to another Committee, but the importance of the matter and its close relationship to the subject of our report are our excuses. We deem it of the highest importance to roads using impure water in the boilers that experiments be made to determine the advantages and cost of purifying water for locomotives by heating and filtration.

Several masters mechanics have suggested to your Committee the propriety of slightly arching the crown sheet, hoping thereby to lessen the incrustations. We do not think this would produce the desired result, for the reason that heavy formations are found on the sides of crown bars, and braces standing nearly vertical.

If scale will form on vertical surfaces it will certainly form on arched surfaces, having a deflection of only 2 in. or 3 in.

Stay bolts, between the crown sheet and the outer shell of boiler, have been and are used instead of crown bars and crown bolts, but they render that portion of the interior of a boiler inaccessible. Nor are they so strong as the crown bar and its bolts, because the crown sheet and the outer shell of the boiler are not parallel surfaces, and the long stay bolts must enter either one or the other at an angle.

Mr. Boon, of the Pittsburg, Fort Wayne and Chicago Railway, suggests that smaller flues than are ordinarily used might be found advantageous. He does not propose to increase the number of but the space between the flues, with a view to obtaining better circulation of water, with a decrease in the loss of heat as it passes through them.

Your Committee have no figures upon which they can base a comparison.

Some master mechanics are of the opinion that 2¼ in. will give better results than 2 in. flues, and we, therefore, recommend that careful experiments be made upon this and kindred subjects.

Your Committee oppose the practice of "blowing off" boilers, especially where impure water is used, because the plates, flues, and braces retain sufficient heat, after the steam and water have left the boiler, to bake the deposit of mud, &c., into a hard scale firmly attached to the surface of the metal.

If the engine is permitted to stand eight or ten hours, until she is comparatively cold, and the water then allowed to run from the boiler, the deposit will be soft enough to wash out. "Blowing off" a boiler, and while it is hot filling it with cold water, is very injurious, and will frequently result in a failure of one or more of the furnace sheets, especially if they are steel.

The economical consumption of fuel is a matter of the highest importance to railway companies.

As practice only can determine the best means for obtaining the full value of the fuel consumed in locomotive and other boilers, your Committee urge their associates in this convention to watch closely the conduct of the different engines under their charge, and gather such facts and figures as will pave the way to correct conclusions.

Very respectfully,

S. J. Hayes,
Superintendent of Machinery, Illinois Central Railroad.
C. F. Jaubert,
Superintendent of Machinery, Chicago, Burlington, and Quincy Railroad.
H. Anderson,
Late General Master Mechanic, Chicago and North-Western Railway.

} Committee.

The Railways of the United Kingdom.—What will possibly surprise at least some is the fact, appearing very strikingly in the Board of Trade report, that there are not less than 599 railway companies in the United Kingdom. England alone has 434 companies, while Scotland has 80, and Ireland 85 companies. The lines of about one-half of the total of these companies are either leased to or worked by the great leaders of our railway republic—true *res publica* if ever there was; but the other half are independent, small enough as often is the area of their sovereignty. As far as can be made out from the blue folio, in which the 599 are marshalled in strictly impartial alphabetical order, the smallest of all independent undertakings in the three kingdoms, as far as regards income, is the railway from Edenham to Little Bytham, four miles long (the sole property, we believe, of Lord Willoughby de Eresby), the total earnings of which in the year 1870 amounted to no more than 428*l.*; while the smallest line as regards mileage is the Ryde Pier, the total length of which is but half a mile, but the revenue of which in 1870 was 10,168*l.*, the little concern carrying 110,983 passengers, the trains running 8011 miles. Contrast these two smallest with the largest of our companies. The "king of railways"—the London and North-Western—represented by a length of 1567 miles open for traffic, carried in the course of the twelve months ending December 31, 1870, the enormous number of 36,340,610 passengers, being just about the total population of all England, Scotland, and Ireland. The number of miles run by the trains of the London and North-Western Railway in the year 1870 was 25,037,577—in other words, a distance more than 100 times that of the moon from the earth, or say equal to 50 return journeys to and from the moon. The gross receipts of the London and North-Western in the year from passenger traffic amounted to 2,042,286*l.*, and from goods traffic to 3,975,723*l.*, the total revenue being 7,014,706*l.*, or almost exactly the same as the national income of Belgium. Next in length of mileage to the London and North-Western comes the Great Western, with 1337 miles open, which earned in 1870 the handsome revenue of 4,316,408*l.*, being equal to that of Bavaria; while behind the Great Western in mileage, but above it in income, stands the North-Eastern, with 1261 miles open for traffic, the receipts of which last year amounted to 4,595,263*l.*, a sum equal to the aggregate revenues of Sweden and Denmark. Looking at these figures, which show the resources of some of our great companies already equal to those of great kingdoms, we cannot but indulge in anticipations as to what the future may bring. The railway giant is still so young.—*Railway News.*

GERMAN RAILWAYS.

The Construction and Maintenance of Permanent Way.

(*Continued from page 348.*)

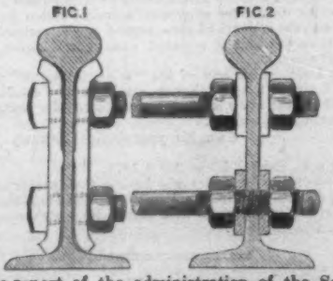
The next question dealt with by the German Association of Railway Engineers, of which we propose to consider the replies, was: What experience has lately been obtained relating to the use of iron permanent way structures? This question has been reported upon by the following railways, on all of which systems of iron permanent way have been employed to a greater or less extent: (1), the Brunswick Railway; (2), the Hanoverian State Railway; (3), The Cologne-Minden Railway; (4), the Lüttich-Mastricht Railway; (5), the Lower Silesian Railway; (6), the Rhenish Railway; (7), the Saarbrück Railway; (8), the Saxon State Railway; (9), the Nassau Railway; (10), the Wurtemburg State Railways; and, (11), the Westphalian Railway.

The different reports state that since 1868 (the year of the last meeting of the association at Munich) no new systems of iron permanent way have been introduced on the railways belonging to the association, but that the systems previously introduced have been used to a much greater extent.

The system which has been mostly adopted is that of M. Hartwich; of this 98,280 yards have been laid down, of which 89,320 yards belong to the Rhenish Railway, 4810 yards to the Saxon State Railways, 2505 yards to the Wurtemburg State Railways, and 1650 yards to the Cologne-Minden Railway. The iron permanent way known as Schweffler's system, composed of three main parts with deep bottom rail, has been laid down for a length of 24,470 yards on the Brunswick State Railway, and for a length of 1640 yards on the Hanoverian Railway. Hilf's system, composed of two main parts, is used on 25,970 yards of the Nassau Railway. Another system adopted to some extent is that of M. Vautherin with iron cross sleepers; this system covers 16,515 yards on the Royal Prussian Railways, the Hanoverian, the Lower Silesian, the Saarbrück, and the Westphalian Railways. Köstlin and Battig's system, consisting of three main parts with a shallow bottom rail, has been used only to a small extent, namely, over 3772 yards on the Saxon State Railways and over 1741 yards on the Wurtemburg State Railways. The Lüttich-Mastricht Railway also has used for four years iron sleepers made of corrugated sheet iron; and it is stated that these sleepers have answered well.

A. *Hartwich's iron permanent way.*—The report of the Rhenish Railway does not express a decided opinion on this system,* but states that in consequence of satisfactory results obtained between the stations Euskirchen-Mechernich and Kempen-Kalden-Kinhen with Hartwich rails 9 in. deep, this system has been adopted for the lines Neuss-Duren 27¼ miles long, and Ehrenbreitstein-Troisdorf and Obercassel-Bonn, 50¼ miles long. The administrative officers of the Rhenish Railway further state that the fish-joints which had been constructed of fish-plates 15½ in. long with eight bolts and of butt-plates 18½ in. long, have not been found to answer, but that joints composed of fish-plates 23¼ in. long with twelve bolts and without butt-plates are most decidedly a great improvement. Sections of this permanent way one-sixth size are given in the annexed Figs. 1 and 2.

FIG. 1 FIG. 2

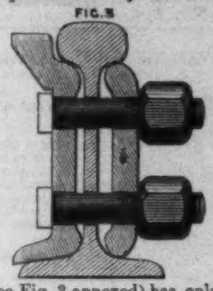


The report of the administration of the Saxon State Railways states nothing in favour nor against Hartwich's system, but points to the small degree of elasticity which it possesses, a feature which causes the riding over a line constructed on this plan to become very hard.

* M. Hartwich is the Government engineer of the Rhenish and several other railways.

The authorities of the Cologne-Minden Railway affirm that they are not yet in a position to express any opinion on the usefulness of Hartwich's system, because the permanent way constructed of rails

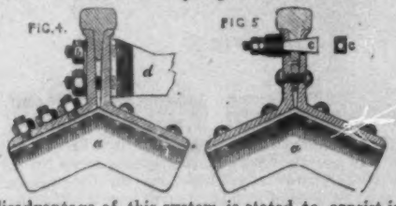
FIG. 3



8 in. high (see Fig. 3 annexed) has only been under traffic for a year and three-quarters; the riding over the road is stated, however, to be certainly much harder than over the road with ordinary cross sleepers. The cost of maintaining the way was during the first year very insignificant.

B. *Schweffler's system of three-part way with deep bottom rail.*—The reports of the administrations of two railways which have adopted this system of permanent way, differ from each other in every important point. The administration of the Hanoverian State Railway confirms the *unfavourable* statement made previously about that system, which had been adopted in 1866 for a length of 1640 yards between Bovenden and Göttingen, the sections being those shown one-tenth size by Figs. 4 and 5. The chief

FIG. 4. FIG. 5



disadvantage of this system is stated to consist in the insufficiently free longitudinal expansion during high temperatures, in consequence of the rusting together of the T-irons which serve as fish-joints, with the angular bottom rails. The cost of maintenance is on this account stated to become very high, especially during the summer.

FIG. 7. FIG. 9. FIG. 8.

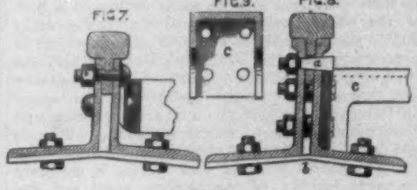


FIG. 6.

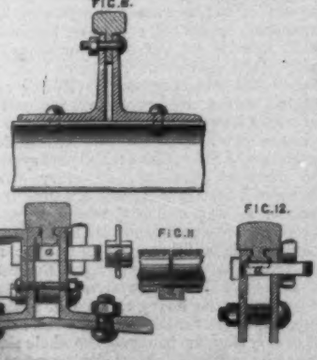
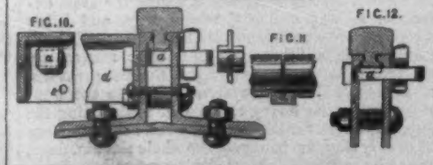


FIG. 10. FIG. 11. FIG. 12.



Figs. 6, 7, 8, and 9 represent Schweffler's system (Fig. 6 being $\frac{1}{10}$ and Figs. 7, 8, and 9, $\frac{1}{5}$ full size) as adopted by the Brunswick State Railways, the officers of which confirm their previously expressed *favourable* opinion of this mode of permanent way construction. An improved arrangement named the Daelen system, shown by Figs. 10, 11, 12 and 13,

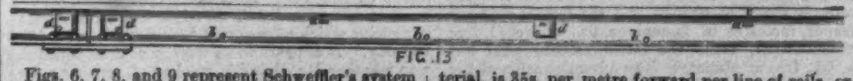
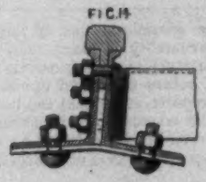


FIG. 13

has consequently been laid down over a length of 20,937 yards between Kreiensen and Holzminden, and the report states that this new way, which had been under traffic for one year, is in every respect superior to any way constructed of timber sleepers. No lateral dislocations of the iron way have been observed, not even in curves. The latter are, however, of 1800 ft. radius. It is also affirmed that the cold weather has no deteriorating influence upon the position of the line of rails, and the present report of the administration of the Brunswick Railways states that the chief condition for securing a firm position of the iron way is the perfect drainage of the bed, and the filling up of the road as completely as possible with clean gravel.

In consequence of the favourable results obtained from the use of this system of iron way, the administration of the Brunswick Railways has finally decided to adopt the construction represented by Fig. 14 for the new line in course of construction

FIG. 14



from Seesen to Osterode, a length of 9.89 miles; this line has curves of 500 yards radius and gradients of 1 in 180.

C. *The three-part way with low bottom rail, Köstlin and Battig system.*—The administration of the Saxon State Railways adopted this iron way (see

FIG. 15.

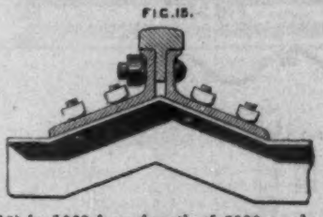
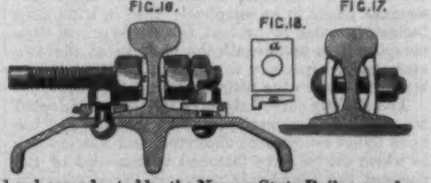


Fig. 15) in 1869 for a length of 3990 yards, and a satisfactory report is now given; this report states, however, that the laying down of this system has to be done with the greatest care, whence the first expense became rather high. A less favourable report on this system is made by the administration of the Wurtemburg Railway, on which line this system of construction has been found to prevent a sufficient free longitudinal expansion, and hence great difficulties have been met with in keeping the way in its proper horizontal and vertical position.

D. *Hilf's system of iron way, consisting of two chief parts.*—This system, shown by Figs. 16, 17, and 18,

FIG. 16. FIG. 18. FIG. 17.



has been adopted by the Nassau State Railway only, and the administration reports most favourably on the results obtained. The whole way is stated to be firmly kept in its proper position, and an alteration of the gauge had only been produced by the wearing of the top rails. The cost of maintenance for this way has been very low, and amounted in 1869 to about 7*l.* 18*s.* per English mile of line of rails. The cost for the new way inclusive of cast steel top rails and wages for laying it down, but exclusive of ballast or bedding material, is 35*s.* per metre forward per line of rails, or say 32*s.* per yard.

E. *Vautherin's system with iron cross sleepers.*—This system, which is shown by Figs. 19 to 23, has been laid down on the Hanoverian, Lower Silesian, Westphalian, and Saarbruck Railways, but only on the latter railway to any great extent, namely, over

TABLE No. V. Showing the Relative Advantages and Disadvantages of Different Systems of Iron Permanent Way.

System of Construction.	Approximate first cost per yard forward.	Maintenance.	Cost of renewing the way.	Character under traffic.	Riding over the way is:	Fractures of the top rail.	Reconstruction of the way after displacement or accidents.
	shillings.						
Hartwich's	22	expensive.	very expensive	firm and safe	very hard	...	very simple and requiring little time.
Schwedler's three-part system with deep bottom rail.	31	expensive.	small (for renewing top rail only)	firm and safe	hard	If cast steel top rails are used, fractures happen not unfrequently, but are not dangerous.	difficult and requiring much time.
Kostlin and Battig's ...	35½	very expensive.	small (for renewing top rail only	too rigid in the connexion of its parts, so that longitudinal and vertical dislocations frequently occur, especially in winter	easy	...	difficult and requiring much time.
Vautherin's	very little more expensive than ordinary timber way.	certainly more expensive than the maintenance of way with wooden sleepers	...	firm and safe	as easy as over an ordinary road with timber sleepers	...	easy and requiring little time.
Hilf's	32	inexpensive	small	firm and safe	easy and uniform	have not been reported	easily executed within a short time.

8½ miles. The administrations of these four railways report favourably on the system, which, however, must be used more extensively, and for a longer period, before a decided opinion should be given. The reports state that the bedding of the sleepers can be conveniently performed, and the trapezoidal section has been found to answer well for cross sleepers; if gravel or ballast of a medium but uniform coarseness is used, a firm bearing is formed underneath the sleeper, which prevents the ballast from extending laterally. The tops of the sleepers ought to be completely filled in with light ballast, in order to prevent the coarse gravel from escaping from underneath the sleepers at the two open ends, especially during the passage of the trains, and when the ballast is in a dry state.

The slightly curved shape of the sleepers adopted for giving the necessary cant to the rails ($\frac{1}{7}$th) has been found everywhere unaltered, and the manner in which the rails are fastened to the tops of the sleepers has completely answered the purpose, it being stated that not a single part of the fastenings had to be renewed. It should be stated, however, that in order to prevent a lifting or getting loose of the lock cottar, great care ought to be taken not to place stones of any considerable size underneath the sleepers. The riding over this way is reported to be as smooth and easy as over a road with wooden sleepers, and the renewal of rails and sleepers may be effected with great rapidity, and better than in the ordinary timber way. Both the Hanoverian and the Westphalian Railways obtained the sleepers from the south of France, and the former paid per sleeper, inclusive of fastenings, 9s., delivered free at Göttingen, while the latter railway paid but 7s. 6d., free at Munster. The administration of the Hanoverian Railway states, however, that a sleeper with fastenings should be obtained from German iron works for 7s. 8d., whilst the Westphalian Railway considers 4s. 6d. as a sufficient price. The cost of maintaining the way of the Hanoverian Railway amounted during 1869 to 55*l.* 10s. per German mile, equivalent to 11*l.* 17s. per English mile. Vautherin's system has also recently been laid down on the Prussian Ostbahn and on the Bergisch-Märkisch Railway.

The system of permanent way with sleepers of corrugated iron, as used on the Lüttich-Maestricht Railway, is shown by the annexed Figs., 24 and 25. It has, as we have already stated, been in use four years, and is favourably reported upon.

FIG.19

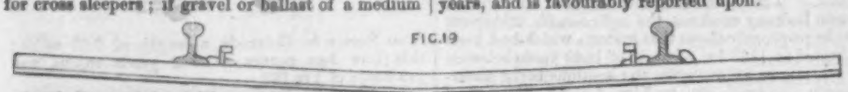


FIG.24

FIG.25

FIG.22.

FIG.21.

FIG.20.

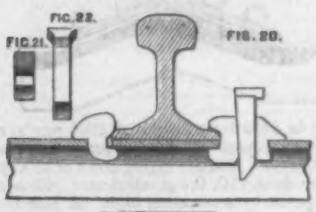
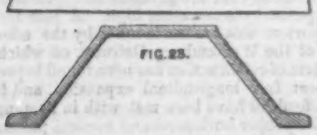


FIG.23.



General Deductions.—Altogether it will be seen that the general result of the reports made by the different railway administrations on the use of various systems of iron permanent way is still rather uncertain. In almost every case each administration reports favourably on the system adopted for its particular railway; but there is an exception in the case of the three-part systems, that with deep and that with shallow but broad, bottom rails being both decidedly condemned, the former by the Hanoverian and the latter by the Wurtemburg Railways. But the three-part system with deep bottom rails has, on the other hand, been used very extensively (20,937 yards completed and 9.89 miles in course of construction) on the Brunswick Railway, and the administration of that line reports so very favourably of it that we are perhaps justified in attributing the failure of the system on the Hanoverian and Wurtemburg Railways, where only about 1640 yards have been laid down, to mere local circumstances. But the weakest point of this system is certainly the great rigidity of the various parts and the absence of the necessary freedom of longitudinal expansion, whilst its costliness (according to the latest data 34s. 6d. per metre, or about 31s. 9d. per yard) is also against it. The three-part system with shallow but broad bottom rail (Köstlin and Battig's system) is even more expensive, the cost being 39s. per metre forward, or about 35s. 6d. per yard.

Hartwich's system has but one disadvantage in common with Schwedler's three-part system, namely, the want of elasticity; in every other respect Hartwich's system is better, allowing the same expansion as any ordinary timber way, and being scarcely more expensive in its first construction, its cost being from 22s. to 24s. per metre forward or, say, from 20s. to 22s. per yard. But the great disadvantage of Hartwich system is, besides the want of elasticity, the heavy expense of maintaining the way, for whenever the top of the rail has been worn off or only slightly damaged, the whole rail 9 in. deep, has to be renewed. Hartwich's system has, however, on the other hand, an advantage in its great simplicity which offers great facilities for repairing the way. It appears to us worthy of consideration also whether Mr. Baines's method of repairing the heads of rails could not be advantageously applied to Hartwich's permanent way.

The administration of the Nassau Railway which has adopted Hilf's system very extensively (14½ miles) reports, as we have seen, very favourably upon it, pointing out especially the firm position of the way and the small costs for its maintainance (7*l.* 18s. per English mile in 1869). The first cost of Hilf's system is about the same as that of Schwedler's three-part system, namely, about 32s. per yard forward (inclusive of cast steel top rail), whilst the latter system offers greater facilities for the renewing of the top rail, and as regards repairing. Altogether Hilf's system appears to be better than Hartwich's, but inferior to Schwedler's system. Greater elasticity is, however, the advantage which distinguishes Hilf's system from Hartwich's as well as Schwedler's system, whence the riding over the former way becomes much easier than over the two last mentioned.

Vautherin's system with iron cross sleepers offers almost the same advantages as the ordinary timber way, and considering that these iron cross sleepers may be substituted for wooden sleepers, whenever the latter have to be removed, it is considered by the association that it remains only to be seen for what price these iron sleepers can be obtained from German iron works, as their importation from foreign countries increases their price to a considerable extent.

The advantages and disadvantages of the various systems of iron permanent ways, as reported by the different lines, are briefly stated in the annexed Table No. V.

(To be continued.)

SELENITIC MORTAR.

To the Editor of Engineering.

Sir,—Your valuable paper for October 6th is just to hand. Allow me to put two questions to Mr. Hedgrave:

1. If similar results are produced by the addition of the sulphate to slaked lime, how can they be explained by the theory that the sulphate merely affects the process of slaking?

2. What is the value of a patent for applying sulphates to unslaked lime, if the same results can be obtained by applying them to slaked lime, which is an old process?

In further defence of my chemical theory I may add:

1. The sulphate of iron certainly does not remain sulphate of iron; for the cement obtains a distinctly reddish tinge, showing the presence of oxide of iron.

2. Oxide of iron being shown to be present, no argument is necessary to prove that the cement will be strengthened and hardened thereby, whatever additional chemical action there may be.

3. Nearly all Portland cements contain a slight excess of lime (which is not injurious to their strength; see last volume of the *Proceedings* of the Institution of Civil Engineers), quite sufficient to enable the suggested chemical action to take place; and the sulphate of lime formed would certainly be harder than the lime it replaced, even if not harder than Portland cement.

4. As I did not use any of the "selenitic mortar" under water, I cannot say whether it contained any soluble ingredient or not; allow me to suggest this to Mr. Hedgrave as a point for experiment.

I am, Sir, your obedient Servant,

C.E.

Bankipore, Bengal, November 8, 1871.

P.S.—I ought to add that not having the opportunity of making delicate experiments, I am not able to assert that the results of my experiments with slaked lime were *equal* to those of General Scott.

The Scott Gun Carriage.—We understand that the committee on explosives are putting the Scott gun carriage for the Devastation's 35-ton gun to a severe test of endurance. It is still at the Woolwich butts, being used for experiment with different natures of powder, under the personal supervision of the committee. In this way it is successfully undergoing a test which is not likely to be exceeded on service. The ponderous weapon is under as complete control, and worked by as few men as the old 8-ton gun, of smooth bore memory, which, not ten years ago, was declared to be the heaviest gun capable of being worked on shipboard.

MONT CENIS TUNNEL.*

The limits of the action of the water column compressor, of which I wrote in my last letter, can be extended to such an extent, that the degree of compression does not depend on the height of the compressing column.†

Referring to the theoretical diagram, Fig. 3 published on page 281 of the current volume, we observe that, from the level, P P, up to the valve, G, the chamber of compression presents a constant capacity. The compressing column, A A A, will always start from the level, P P, and will again return to a state of rest, after having reached G. The effect produced by the column between the beginning and the end of the motion, is a fixed quantity of mechanical work, the maximum limit of which is represented by the product of the volume of water corresponding to the capacity of the chamber, B, multiplied by the density of the water; and for the height of the column of compression the half of the height of the chamber, B, being deduced.

Now this determined quantity of work is concentrated in a volume of atmospheric air equal to the capacity of the chamber, and compressed to the tension which is to be obtained. It can, however, be concentrated in a smaller volume if the air is compressed at a higher tension, and it is evident that as the work to be concentrated remains constant, the smaller the initial volume of the atmospheric air to be compressed is, the greater will be the final tension of the air. Whence it results that the heights, remaining constant, both of the compressing column and the chamber of compression, it will be possible, with the same compressor, to obtain air at as high a tension as may be required, so long as only such a volume of air is admitted to the compression chamber, that, in order to absorb all the work of the column, shall assume the corresponding tension.

This is effected in the following manner: The chamber, B, is filled entirely with natural air from the level, P P, into the valve, G; but instead of making such arrangements as to make the compressing column compress the air from this level, P P, such a quantity of air is allowed to escape as would represent the volume by which it is wished to diminish the capacity of the chamber, B, the whole effect of the compression being exerted on the remaining quantity of air. The small hanging valves, h, h, h, kept open by their own weight, are used for this purpose; but they can be closed entirely, and the compressor can be reduced to its normal state by closing them all, or any number of them can be closed, and the remaining ones left open; hence the capacity of the chamber may be regulated according to requirements.

Let us now suppose that the compressing column has sunk to the level, P P, and let it be ready for a pulsation; if all the "clapets," h, h, h, were closed, the pulsation would be normal, and it would take place, as already described; but if these small valves are open, the air raised by the compressing column will not be compressed, but will escape partially through the "clapets;" when the ascending column shall have reached these "clapets," in consequence of its greater density, it will close them successively, and when the last has been closed, the ascending column will begin to compress the air above it, which is reduced in volume to an extent depending upon the position of the top valve, h, to the valve, G. The motion of the compressing column will be entirely arrested, as in the normal pulsation, and a much smaller volume of compressed air will be obtained, but it will be compressed to a far higher tension.

From what has been said above it is clear:

1. That a certain volume of water being given, with a given height of fall, the most convenient height will have to be determined, which is to be given to the compression chamber, keeping its sectional area constant, and the normal condition of the compressor will be that which gives the greatest possible volume of compressed air with the least possible tension.

2. That if it be wanted to accumulate air at higher pressure this can be effected by means of a series of hanging valves placed in the side of the chamber, arranged either vertically or spirally.

In order to regulate the normal working of the compressor, it is necessary that the tension of the air in the chamber, D, should remain constant, because if the pressure diminishes too much, then the valve, G, would be raised before the air would gain in the chamber, B, its normal tension, and the compressing column would not reach the valve with an expiring velocity, but with a velocity determined by the reduction of the pressure in the chamber, D, and a shock more or less violent would result. If, on the contrary, the tension in D would augment, then the compressing column would lose its *vis viva* in compressing the air of the chamber at a pressure higher than the normal pressure, and only a part of the air would pass into the chamber, D, at each pulsation, in which the pressure would increase until the valve, G, could be lifted no more, and the pulsations would be changed in a series of unproductive oscillations.

In order to keep the tension constant in the chamber, D, it is evident that the discharge of air from it must be proportional to the work done by the compressor in compressing air to a given tension.

To find the equation which regulates the movement of the compressing column of water, let us suppose that the vessel in which the water moves should be formed in one part as a "reservoir," and in another as a long tube of constant section.*

Let ω be the constant section of the tube;

u = the velocity of the water in the same;

H = the height of the water-fall, that is, the difference of level between the discharging valve and the highest level of the water in the reservoir;

x = the varying height of the head of the compressing column, which, by moving, compresses the air, this height being taken from the discharging valve;

z = the length of the axis of the tube, taken from where it issues from the reservoir to where the water reaches in the chamber of compression at the beginning of each pulsation;

p_0 and p = external pressure and the variable pressure respectively, which exist in the chamber of compression;

G = the specific gravity of water;

g = the accelerating force of gravity.

In order to obtain the equation which regulates the motion of this mass of water, we calculate the expressions of the work done by the various forces which act on the mass of water in a given interval of time, and make the sum of these expressions equal to the half of the variations of the *vis viva* of the mass.

The work done by the pressure, p_0, in a given interval of time is equal to the volume of water passed in the same time, multiplied by the pressure, p_0, calling X the height at which the water reaches in the chamber of compression at the beginning of the interval of time which is given, the work done by the atmospheric pressure will be:

$$\omega p_0 (x - X).$$

The work owing to the variable pressure p, which is applied on the section ω of the head of the advancing water, which is represented by:

$$-\omega \int_X^x p\, dx.$$

And, again, the work due to the force of gravity, results from the passage of the cylinder of water $\omega (x - X)$ from the superior level of the reservoir, into the chamber of compression, and will hence be given by the product of the multiplication of the weight of the same quantity of water, by the difference of level between the centres of gravity of the same in the two different positions.

Now, the centre of gravity of this column of water in the first position is on the surface of the water in the reservoir, and hence at a height, H, above the discharging valve, whereas the same centre of gravity in the second position is at a height $\frac{x+X}{2}$, so that the difference of level between these two centres of gravity will be:

$$\left(H - \frac{x+X}{2}\right),$$

and hence the work done by the force of gravity in that space of time is:

$$\omega G (x - X)\left(H - \frac{x+X}{2}\right).$$

At every instant the *vis viva* of that quantity of water in motion is composed of two parts; one part is owing to the water in the reservoir, the other is due to the water in the tube. And as the reservoir is of great size as compared to that of the tube, it results that the water in the reservoir has a very slow motion, and hence the *vis viva* of the water which is in it can be neglected, as compared to that of the water which flows through the tube, and hence at every instant the *vis viva* of that mass of water may be represented by:

$$\frac{G}{g} \omega (z + x) u^2,$$

and if U be the velocity of the water in the tube at the beginning of each interval of time, the equation which regulates the movement of that mass of water will be the following:

$$(1)\quad \frac{p_0}{G}(x - X) - \frac{1}{G}\int_X^x p\, dx + (x - X)\left(H - \frac{x+X}{2}\right) = \frac{1}{2g}\left\{(z+x)u^2 - (z+X)U^2\right\}.$$

In order to have a relation between the velocity U and the time t, we observe that $U = \frac{dx}{dt}$, and hence:

$$t = \int \frac{dx}{u},$$

and substituting for u the value given by the equation (1), we shall get the general expression of t in functions of x.

In my next article I shall refer to the different phases of the action of the compression, and shall give the mathematical expressions corresponding to them.

F. Kossuth, C.E.,
Royal Commissioner for Railways in Italy.

* Continued from page 283.
† See Report of the Technical Directors, 1863.

* See Report of Signor Giacinto Gautero, C.E.

PERUVIAN RAILWAYS.

The following translation of a report bearing date the 22nd of September last, and addressed by Mr. Henry Meiggs to the Minister of Public Works in Peru, will be read with interest, as it contains an exact statement of the condition of railway matters in that country:

Your Excellency,—In fulfilment of the request with which you favoured me in your letter of the 18th inst., I have the honour to give you herewith the most exact information possible respecting the number of miles of railroad at present partially executed, the distance on which permanent way is already laid, and that portion which is open for traffic; also what is still required to complete the railways of Cajamarca (section from Pacasmayo to Magdalena) Oroya, Puno, Moquegua, with the line necessary to definitely complete these works.

Railway from Callao and Lima to Oroya.—The locomotive at present traverses the section comprised between Callao and San Bartolomé, a distance of about 46 miles, which is now fully laid with rails, and levelled throughout to its respective gradients.

In addition to this the finished earthworks may be estimated at 15 miles, making a total amount of earthworks executed of 61 miles. There then remain to be finished 75 miles of earthworks and rail-laying, in which portion several tunnels and heavy cuttings occur. To recapitulate:

Open for traffic	46 miles
Completed for track	15 „
Total earthworks	61 „
In course of construction to complete line	75 „
Total extension of line	136 „

Locomotives and plant are constantly arriving, and I calculate that the work will be finished within three years of the above date.

Railway from Arequipa to Puno.—There are at present 15 miles traversed by locomotives, and the laying of rails on the balance of finished road proceeds rapidly.

Completed	15 miles
Earthworks receiving rails	85 „
Still to be executed	125 „
Total extension of line	225 „

Locomotives and stock are constantly arriving, and the road will be completed within two years from present date.

Railway from Ilo to Moquegua.—Of this line 37 miles are ready for the rails, leaving 24 miles in process of rapid construction, and giving a total distance of 61 miles. Some of the engines have arrived and rails are expected daily. The portion of roadway in course of formation will be finished in six months from this time and the entire line ready for delivery to the Government nine months hence.

Cajamarca Railway—Section from (Port) Pacasmayo to Magdalena.—Up to this date, 36 miles of road are prepared for rails, of which a cargo has already arrived, and further lots with some locomotives, are expected. I anticipate that this line will be finished in fifteen months from now, with the exception of the mole which will require a little more time. I expect that the locomotive will before this year expires, traverse the section between Pacasmayo and Guadaloupe.

I trust that the dates quoted may meet the wishes expressed by your Excellency and I remain always fully prepared to give you any details which may be desired respecting the works intrusted to my charge.

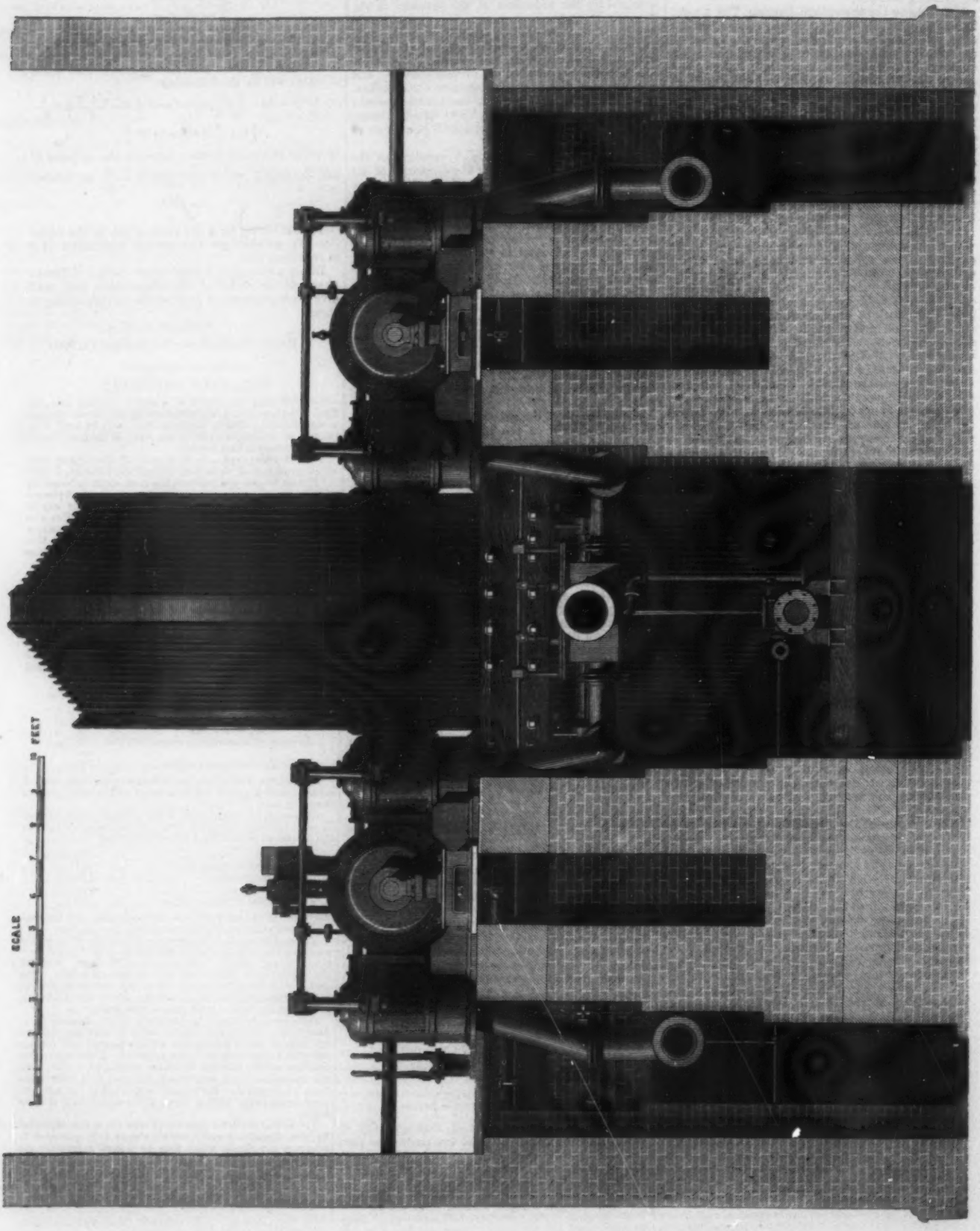
Your Excellency's faithful Servant,
for Henry Meiggs,
John C. Meiggs.

Lima, September 22, 1871.

WINDING ENGINES AT THE SKELTON IRON MINE, SALTBURN-BY-THE-SEA.

CONSTRUCTED BY MESSRS. JOHN MUSGRAVE AND SONS, ENGINEERS, BOLTON.

(For Description, see Page 376.)

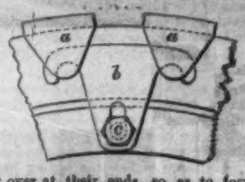


THE SMITHFIELD CLUB SHOW.

THAT sure forerunner of Christmas, the Smithfield Club Show, has been held during the present week at the Agricultural Hall, and it thus becomes our duty, in fulfilment of an annual custom, to direct the attention of our readers to such novelties as the meeting has called forth. In the present instance, however, this task is an unsatisfactory one. So far as we have been able to discover, the Agricultural Hall this year contains but very few novelties of any kind, while it certainly contains none destined to have any material effect on the progress of agricultural engineering. The fact is that, as we have remarked on previous occasions, the leading makers of agricultural implements all bring out their important improvements at the great summer meetings of the Royal Agricultural Society when the machinery can be shown in action, and when prizes are awarded; and the Smithfield Club Show thus becomes really little more than a bazaar for the sale of machinery which has already been introduced to the public. There are, of course, some exceptions to this rule, but they are few and far between, and hence, regarded from an engineering point of view, the Smithfield Club Show at no time possesses any very great amount of interest, while this year that interest is from various causes less than usual.

In reality the matter which has attracted most attention at the Show during the last few days is the question of prices. The general adoption of the nine hours' movement and the present increase in the cost of materials, had given rise in many quarters to a desire to raise what have for some time past been the standard prices of portable engines and thrashing machines; and there can be no doubt that such a rise would have been resolved upon had it not been for the action taken in the matter by Messrs. Clayton and Shuttleworth. Standing at the head of the trade as Messrs. Clayton and Shuttleworth do, their decision was naturally regarded with some anxiety, and the announcement made by them last Monday, therefore, that, relying upon their facilities for production, they intended not to increase but to reduce the prices of their portable engines, was received with feelings generally differing in a material degree from satisfaction. However this may be, the fact remains that Messrs. Clayton and Shuttleworth *have* reduced the price of their portables by 10*l.* per engine, and the effect of this reduction on the prices generally charged in the trade remains to be seen. At present some of the makers appear inclined to follow suit; others adhere to the old rates, and others again still contemplate a rise. Ultimately, however, it is most probable that the reduction will become general, although whether this reduction will in all cases be a benefit to the purchaser is questionable. The reduction is undoubtedly a blow at the system of giving excessive discount to agents, and regarded from this point of view, we believe that it is likely to do good. The fact is that of late years agents have increased in number to an inordinate extent, and their discounts have in too many instances grown far beyond the amounts compatible with the interests of either the manufacturers or purchasers. This subject of agents is one on which we could, if we chose, write much; but the present is scarcely the place for discussing the matter, and we shall therefore say no more concerning it. Before leaving the question of prices, however, we should notice that Messrs. Clayton and Shuttleworth have in common with a number of other firms given notice of an increase in the price of their thrashing machines, and those who are well acquainted with thrashing-machine construction, and the many improvements and additions which have been made to such machines of late years, will own that the increase is a most justifiable one.

Turning now to the exhibits at the Agricultural Hall, we find that of steam ploughing engines but one example is exhibited, that being a 12-horse single cylinder engine, shown by Messrs. John Fowler and Co., of Leeds. This engine is a thoroughly good specimen of a class which brought honour to the firm at Wolverhampton; but it includes no novelties of construction requiring description here. Messrs. Fowler also exhibit a variety of steam cultivating implements of their usual patterns, and an 8-horse traction engine, of strong and simple design and their usual excellent workmanship. We also noticed at Messrs. Fowler's stand a wheel with an india-rubber tyre having a new arrangement of shoes in place of the ordinary Thomson chain. The annexed rough sketch will convey an idea of the plan. From this sketch it will be seen that the shoes,

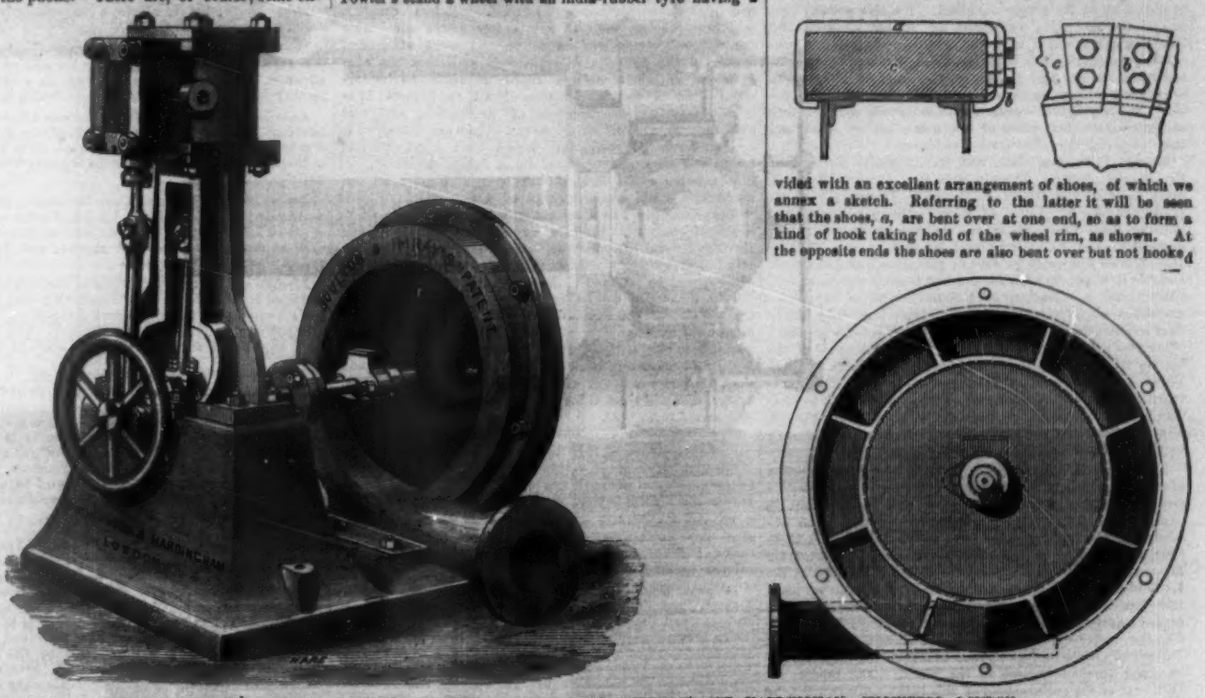


a a, are bent over at their ends, so as to form eyes into which pieces of the form marked *b* are hooked. These pieces couple up the shoes into successive pairs, and they are held by bolts which pass through them and the angle irons inside the tyre of the wheel, as shown at *c*. The bolts, *c*, extend right through the wheel, so that each holds two pieces, *b*, on opposite sides of the tyre. The bolts pass through slots in the pieces, *b*, so that these pieces can yield when the tyre is compressed by the load coming upon it.

Messrs. Aveling and Porter do not exhibit any ploughing engines this year, but they show one of their well-known agricultural locomotives of the same type as the 10-horse which did such good work at Wolverhampton, and also one of their 20-ton steam road rollers. This is, we believe, about the best size of steam road roller for general work, and the example exhibited is just what such a roller should be. We notice that Messrs. Aveling are adopting in almost all cases their system of carrying up the side plates of the firebox casing so as to form the brackets for carrying the crank-shaft bearings, &c., a system of construction which has many points to recommend it, and which is, as we have noticed at Wolverhampton, also being adopted by Messrs. Fowler.

Mr. Charles Burrell, of Thetford, is the exhibitor of a very well built traction engine of a design which he has adopted for some little time past. In this engine the driving axle is placed beneath the barrel of the boiler, and the leading wheels are placed as in the engine illustrated by us on page 39 of the present volume. The engine exhibited differs, however, from that just mentioned in having but a single cylinder, the crank shaft being at the smokebox end of the boiler. With a single cylinder engine this is, we think, an inconvenient arrangement, as if the engine stops on a dead centre it cannot be readily started. No doubt by proper care the engine can be prevented from stopping on the centre; and in practice it is stated that the arrangement does not give rise to trouble; but proper care is not always exercised, and we are glad to hear, therefore, that Mr. Burrell is about to build these engines with the crank shaft at the firebox end, where the fly-wheel will be readily accessible. In the engine under notice the boiler is mounted on bearings on the driving axle, and by means of a quadrant rack and screw at the leading end, the water level can be adjusted when the engine is ascending or descending hills. The leading wheels are rigid, but he driving wheels are fitted with india-rubber tyres, provided with an excellent arrangement of shoes, of which we annex a sketch. Referring to the latter it will be seen that the shoes, *a*, are bent over at one end, so as to form a kind of hook taking hold of the wheel rim, as shown. At the opposite ends the shoes are also bent over but not hooked, the hook being in this case formed by loose pieces, each of which is bolted to its shoe by two set screws, as shown in the section. The shoes thus formed are easily made, very readily removed or replaced if injured, and lastly if one of them falls it in no way interferes with the action of the rest. Altogether we like these shoes much better than the "chain armour" ordinarily used by Mr. Thomson. We noticed that in Mr. Burrell's engine some of the gearing ran much closer to the wheel tyre than was desirable, and was not efficiently protected from the dirt thrown up by the latter. This, however, is, we believe, explicable by the fact that this particular engine was not originally intended to have elastic tyred wheels, and that hence there was some crowding which would be avoided in an engine specially built for such wheels.

While speaking of traction engines, we must not forget to notice a remarkable specimen shown by Messrs. Ashby and Jeffery. Engineers desirous to know how long a piece of overhanging shafting with a pinion at the end of it can be used for driving the wheels of a traction engine are recommended to examine this exhibit. When they see the distance which in this case exists between the driving pinion and the nearest bearing, they will probably be surprised and delighted. We will not, however, criticise the engine further. Another somewhat curious piece of designing was to be found at Messrs. Robey's stand (not that Messrs. Robey were in any way responsible for it, however), in the shape of an elastic wheel, in which the elasticity is obtained by the employment of a number of steel springs of the ordinary laminated plate kind. These springs are disposed transversely all round the wheel, each spring being interposed between the rigid rim and a kind of shoe of peculiar form, which is prevented from moving outwards radially beyond a certain distance, by being locked by other shoes on each side of it. These intermediate shoes, which are alternated with the movable or spring shoes, are attached to the wheel rim and are arranged so that the pressure of the load shall not come upon them until the spring shoes have been forced home. A good deal of ingenuity has been displayed in working out the details of this wheel, which is, we believe, principally the



BOULTON AND IMRAY'S HELICAL PUMP, CONSTRUCTED BY MESSRS. BROTHERHOOD AND HARDINGHAM, ENGINEERS, LONDON.

design of a farmer in the neighbourhood of Lincoln; but we regret to say that we see no prospect of the system of construction being one that will give satisfactory results in practice.

In portable and fixed engines there is scarcely anything new to report upon. Messrs. Clayton and Shuttleworth exhibit as usual a magnificently finished horizontal fixed engine which is a perfect picture in its way, and also some of their portable engines, and a double cylinder traction engine of a pattern which they have for some time adopted. We may mention here by-the-bye that any one who wishes to see what mechanical design really ought to be should examine the governor bracket and valve spindle guide of Messrs. Clayton and Shuttleworth's fixed engine just mentioned. We venture to say that no bracket more perfectly proportioned and thoroughly adapted to its purpose has ever been turned out of any factory. We wish heartily that the designers of some of the mechanical abortions which we noticed in several parts of the show could have models of this bracket kept perpetually before their eyes until they became educated up to the proper standard. We also noticed that one of the portables exhibited by Messrs. Clayton and Shuttleworth is fitted with wrought-iron brackets for supporting the crank-shaft bearings, these brackets being connected on the one side to the cylinder, and on the other to the firebox casing by tie rods. These brackets are probably slightly lighter—even when the tie rods are taken into consideration—than those of cast iron; but we must say that we prefer the latter for several reasons.

Messrs. Ransomes, Sims, and Head, Messrs. Robey and Co., Messrs. Ruston, Proctor, and Co., Messrs. Marshall, Sons, and Co., and Messrs. E. R. and F. Turner, all exhibit good examples of engines of their ordinary patterns; but none of these firms, so far as we are aware, show any novelties. The same may also be said of the Reading Iron Works Company as far as portables are concerned; but this firm also exhibit for the first time at the Smithfield Club Show a collection of the neat type of horizontal stationary engines, which they introduced in July last at Wolverhampton, and which we described at the time. They also show at the Agricultural Hall an example of the boilers which they are now supplying with these engines. This is a plain cylindrical boiler, the lower part of which is traversed by tubes extending through it from end to end. The boiler is set with the fire beneath it, and the hot gases, after passing along under the bottom of the boiler, return to the front end through the tubes.

At Messrs. Howard's stand we noticed a sample section of a form of their safety boiler with horizontal tubes—a form which they are now introducing to a large extent in cases where sufficient height cannot conveniently be obtained for the vertical tube type, which latter type, however, we ourselves prefer. We intend shortly to illustrate Messrs. Howard's horizontal tube boiler as applied at the Lackenby Iron Works, near Middlesbrough, and we need therefore say nothing more concerning it here. At the opposite corner of the Hall to Messrs. Howard's the Davey-Paxman boiler was shown by Messrs. Davey, Paxman, and Davey, of Colchester, as applied to one of the most neatly-designed vertical engines in the Show. The reports we still hear of the performance of this boiler fully justifies the favourable opinion we formerly expressed concerning it.

Messrs. Wallis and Steevens, of Basingstoke, show a portable engine with a new arrangement of feed-water heater, which we intend to illustrate shortly; but respecting which we may nevertheless say a few words here. This heater consists of a casting placed by the side of the boiler, and traversed by three wrought-iron tubes. The exhaust steam is passed through this casting on its way from the cylinder to the smokebox, and it thus surrounds the tubes; through which latter the feed-water is pumped on its way to the boiler. The chief peculiarity in the arrangement consists in each of the tubes having placed within it a wrought-iron core bar of such diameter that an annular space, but ¼ in. wide, is left through which the water is passed. This arrangement causes the water to be brought well in contact with the steam-heated surfaces, and the efficiency of the latter is increased by the steam and water being made to traverse the latter in opposite directions. The core bars can be readily removed for the purpose of cleaning the tubes, and the arrangement appears to us to be a very good one.

Amongst the few novelties in the Show we must notice Boulton and Imray's helical pump, exhibited by the makers, Messrs. Brotherhood and Hardingham, of 56, Compton-street, Clerkenwell. This pump, of which we publish engravings in the preceding page, simply consists of a disc with suitable blades revolving within a casing, of the shape shown in the figures. From the latter it will be seen that the outer part of the casing forms a helical passage making a complete revolution from the point of entrance to the point of delivery, and in this passage the blades on the disc work. These blades stand slightly obliquely to the plane of the disc, and as the latter revolves, the blades, as it were, shunt the water gradually from the inlet to the exit orifice. The passage through the pump is of uniform sectional area, but tapering nozzles having the form of the *vena contracta* are fitted to the inlet and outlet pipes to enable the water to be gradually put into motion, and to reduce its speed after delivery. The pump is a very simple one, and it appears very well adapted for use as a circulating pump in connexion with surface condensers. The makers have made many careful experiments with this pump, and they state that it gives a very high coefficient of efficiency. One of the views published by us on the preceding page shows one of the pumps under notice driven by a little vertical engine coupled direct to the pump spindle, the engine and pump being mounted on the same bedplate. The other figure is an internal view of the pump, one-half of the casing being removed. Messrs. Brotherhood and Hardingham also exhibit a number of their capital "Paragon" steam pumps, a small horizontal engine of a new and very neat design, and a new form of governor which we intend to illustrate shortly, and which, therefore, we need not describe here. We should remark, before leaving Messrs. Brotherhood and Hardingham's stand, that the workmanship of their exhibits well deserves a word of commendation, and forms a striking contrast to that to be found in some parts of the galleries.

We have noticed comparatively few exhibits certainly, but if we except Mr. Boby's self-acting corn screen (described by us on another page of the present number), we have, we believe, noticed all novelties possessing any claim to engineering interest. Before concluding, however, we wish to say a few words concerning the "cheap" steam engines to be met with at several stands in the galleries. We sincerely wish that the constructors of such engines could be made to understand that a simple defiance of all mechanical laws is not essential to cheapness of production, and that cast iron is not necessarily more costly when employed to produce forms of reasonable design than when cast into lumps and masses having no claim to design whatever. If it were not for the fear of inflicting nightmare on our readers we would get drawings of a fair sample of these "cheap" engines, and illustrate it to a large scale in all its naked hideousness. Perhaps we may even do so yet, and risk the general consequences, hoping that some good may result. Seriously, however, it is quite time that such engines ceased to be made. Engines of good proportion and fair workmanship can be manufactured equally as cheap as the monstrosities to which we are referring, and this several firms have for some time proved. If the makers of some of the curious pieces of mechanism to be seen at the present Smithfield Show will but take the trouble to acquire but a very moderate amount of information on steam engine design, and will turn it to account, we shall see a vast improvement next year.

FOREIGN AND COLONIAL NOTES.

Stamboul Tramways.—These tramways have been opened to the public. Carriages run every ten minutes from the bridge to Ak-Serai beyond the Seraskeriate, and *vice versâ*.

Russian Ironclads coming to Grief.—Two Russian ironclads have got into difficulties, the Lazareff having been run into and all but sunk by the Spiridoff, which was herself much injured by the collision.

Chicago, Danville, and Vincennes Railroad.—The Chicago, Danville, and Vincennes Railroad Company, has completed its road from Chicago to Danville; and the Evansville and Terre Haute Company has also completed its line north to Danville, thus forming a new and almost air-line route from Chicago to the Ohio, and thence by the Henderson line to Nashville and all points south. The striking feature of this important work is that it places the Indiana block coal-fields in direct communication with Chicago and the north-west.

Rybinsk and Bologoe Railway.—It is proposed to extend this Russian line from Bologoe, a half way point on the St. Petersburg and Moscow Railway, to Pskov on the St. Petersburg and Warsaw line. It is also in contemplation to continue the extension to Riga, and from Riga to Libau, the only northern point which is open during the winter. The projected extension is perfectly straight and presents scarcely any engineering difficulties.

Turkish Railways.—The earthworks on the continuation of the Kutchuk-Tchekmedje Railway from the Seven Towers into Stamboul, are nearly completed and the contractors are about to ballast the line and lay the sleepers and rails. Difficulties attending questions of compensation for property required for the passage of the line having been at length settled by an expropriation commission, the construction of a central terminus in Stamboul will be at once commenced.

Russian Ordnance.—The Russian Government has ordered from the Alexandrovski foundry in the district of Olonetz 70 pieces of cannon (10 24-pounders and 60 12-pounders), 20,000 24 lb. shells, 46,900 12 lb. and 2500 9 lb. bombs, and 70,000 spherical 3 lb. cannon-balls. Several 11-inch Krupp guns have been mounted on Fort Constantine at Cronstadt.

The Anchor Line of Steamers.—In 1863, the Anchor line comprised three steamers. In 1871, the total had expanded to 36 steamers.

Railways in Japan.—Mr. Christy, who has been for fifteen years superintendent of the Victorian Government railways, proposes to leave Victoria for Japan if, indeed, he has not already done so. Mr. Christy has received an appointment in connexion with the Japanese Government lines.

Railways in New South Wales.—The New South Wales Commissioner for Railways (the Hon. J. Byrnes) and the colonial engineer-in-chief for railways (Mr. J. Whitton) have inspected the works upon the Great Western line of the colony. An order has been given by the commissioner to Messrs. Mort and Co., of Sydney, for the construction of four locomotives according to the designs by Mr. J. R. Thomas.

The Australian Overland Telegraph.—The advices received in Adelaide from the working parties engaged in the construction of the great Australian Overland Telegraph are stated to be satisfactory. The works are being pushed on with vigour and communication will soon be made good for 1100 to 1200 miles north of Port Augusta. Messrs. Darwent and Dalwood have commenced an action against the South Australian Government for annulling their contract for the Northern Territory sections of the Overland Telegraph. The damages are laid at 50,000*l.*

Cheap Railways in South Australia.—The South Australian Government has brought forward a project for connecting the agricultural district of Narracoorte with Lacepede Bay, a distance of 50 miles, by a light railway to be worked with horse power. The estimates which have been prepared upon the subject show that the line may be carried out for 3000*l.* per mile.

Working Railways by Water.—A plan propounded by Mr. Sanderson for dragging carriages up the Himalayas by means of water power, has been under the consideration of the Indian Department of Public Works. The plan of Mr. Sanderson is known as Sanderson's hydraulic propeller, but the details forthcoming respecting it are at present somewhat hazy. The speed promised is slow, not more than five miles per hour; but, of course, a comparatively slow motion would suffice for goods traffic.

East Indian Railway.—The Governor-General-in-Council has expressed his satisfaction with the efficient state of the works of the East Indian Railway, as evidenced by the manner in which they have withstood recent heavy floods.

American Telegraphy.—The American telegraphic system has been extended to Fort Ellis, in Northern Montana. The first telegram received at Washington from Fort Ellis was in the following words:—"Fort Ellis greets Washington. All well."

Indian Coal.—The expenditure incurred in connexion with coal-boring operations in the Chonda district up to the close of the financial year 1870-1 was as follows:—1868-9, 6719 rupees; 1869-70, 41,517 rupees; and 1870-1, 48,818 rupees; total, 97,054 rupees.

Mechanical Industry in New Zealand.—A steam hammer has been recently fitted up at Messrs. Kincaid, M'Queen and Co.'s foundry (the Vulcan), Great King-street, Dunedin, in the province of Otago, New Zealand. The hammer was used recently in repairing a broken shaft of the steamship Maori.

The Stranton Iron and Steel Company.—We notice the prospectus of a new company to be formed for the purchase of the recently erected Stranton Iron and Steel Works, at West Hartlepool. The proposed capital is 100,000*l.*, in 10,000 shares. The property consists of puddling and heating furnaces, rolling mills, steam hammers, engines, and general plant, and the price to be paid to the vendors is 35,000*l.* in cash, and 3500 fully paid-up shares. This price includes the sale of certain patent rights.

The European and South American Telegraph.—A prospectus has been issued of the European and South American Telegraph Company (limited), with a capital of 1,250,000*l.* in shares of 20*l.* to establish a submarine line from Portugal to Brazil, *vid* Madeira, St. Vincent, and Cape Verd, terminating at Cape San Roque, where it is to connect with the telegraphic systems of Brazil, Uruguay, and the Argentine Republic. The concessions acquired by the company are from France, Portugal, and Brazil, and give, as to the particular points named, exclusive rights for sixty years, the consideration to the original grantees being one-third of any net profits after payment of an average dividend of 10 per cent. per annum to the shareholders, and an appropriation of 2 per cent. to a reserve fund. A contract for the construction of the cable for 1,150,000*l.* has been made with Hooper's Telegraph Works.

Proposed Caspian and Black Sea Canal.—The proposal to connect the Caspian Sea with the Sea of Azoff by means of a canal was discussed at a recent sitting of the Russian Geographical Society. A plan of the canal, according to which it is to pass between the Kuma and the Manytch, was laid before the society by the Grand Duke Constantine, and Prince Krapotkin read a report on the subject. The first accurate survey of the country, he said, was made by Von Baer, who visited the Manytch valley in 1855; and in the spring of 1858 Herr Bergsträsser endeavoured, when the water was high, to pass from the Caspian to the Sea of Azoff in a boat. In 1860 the expedition of Colonel Kostenkoff, who was accompanied by MM. de Marny and Kryshin, surveyed the valley of the Manytch from the great Manytch-Liman to the mouth of the river Chulebe. Finally, in the years 1863 and 1864, Captain E. Blum, of the military topographic corps, made a trigonometrical survey of the whole of the eastern valley of the Manytch up to the Caspian, and bored through the earth to the depth of four fathoms at six different places to the east of the mouth of the Kalan. The results of these investigations was the project of a canal, though the data are still very incomplete, as the western Manytch has not yet been explored for a distance of 350 versts. Three different modifications of the plan give the quantity of earth to be excavated as 65,131 and 78 millions of cubic fathoms respectively. In estimating the cost of the excavations, Herr Blum takes as his standard the expense of the works on the Suez Canal, where the quantity of earth excavated was 28,000,000 cubic metres. On this basis the cost of the first of the above projects would be 422,000,000 roubles (58,000,000*l.*), of the second, 641,000,000 (100,000,000*l.*), and of the third, 507,000,000 (64,000,000*l.*). These figures, thought Prince Krapotkin, render it impossible for the Geographical Society to entertain the project. After a long debate, in which M. Romanoffsky endeavoured to prove that the cost of such excavations has now become much less than formerly, and will continue to diminish, the society passed to the order of the day, on the ground that Captain Blum's project does not furnish any positive data for a thorough consideration of the subject.—*Pall Mall Gazette.*

STEAM ENGINE COEFFICIENTS.

TO THE EDITOR OF ENGINEERING.

SIR,—Mr. Smith complains that the extract from his letter, presented by me last week, "does not contain all the qualifications that give that extract its real meaning." This objection can be easily removed by agreeing that the umpire shall in any case be allowed to ascertain what is the real meaning by referring to any part of the whole correspondence.

No referee can be expected to give his time to this question without remuneration, and I hardly think that any one, in the position named by me, would be willing to do it for money. It was on this account that I proposed to give the referee the selection of a charity. To have five pounds more to give away at this season would be a pleasure, making the work to earn it an honour. The mode of settlement proposed by me is, therefore, no "undignified resort." Mr. Smith, in last week's letter says:

"Now, as Mr. Gray has taken the liberty of proposing to narrow so much the settlement of 'the whole question,' I will take the liberty of narrowing it a little further just to simplify the settlement, and then I will with the greatest pleasure accept the mode of settlement proposed. It is the accuracy of my formula that he mainly disputes. It is deduced from Rankine's approximate equations for the non-transmission curve, and, using Rankine's symbols it is this:

$$\frac{P_m}{P_0} = 10\,r^{\frac{1}{m}} - 9,$$

or substituting:

$$\frac{\text{Mean total pressure}}{\text{Final pressure}} = (10 \times 5.845^{\frac{1}{3}}) - 9 = 3.167.$$

"This is my formula, pure and simple. If the referee decide that it is correct, Mr. Gray will send for publication in your journal a retraction of all his letters, and a sum of five pounds to be given to any charitable institution the umpire may elect; should the decision be that the formula is wrong, then I will retract my letters and pay five pounds as above."

He says this is what I mainly dispute, whereas there is not in all my letters a single figure or a single word that does not agree with the above formula. If he can find any sentence in all my letters that he thinks will bear such a construction, I agree that that sentence be submitted as he proposes. If the umpire decide that I have ever questioned that formula I will give in.

Or, refer to the quotation I gave last week from Mr. Smith's letter of Nov. 22. Mr. Smith thus expresses my "grand blunder:"

"In the case in point Mr. Gray's formula for the total gross coefficient is this,

$$\text{Gross coefficient } 3.2355 = 1 + \text{hyp. log. } 1.882 + 9 - \frac{9}{5.845^{\frac{1}{3}}}$$

When it should be,

$$\text{Gross coefficient} = 1 + \text{hyp. log. } 1.882 + (10 \times 5.845^{\frac{1}{3}}) - 10."$$

Let the question be which of these two agrees with the formula which he says I dispute, and which he claims as his "pure and simple." My "grand blunder" *does* agree with it, and Mr. Smith's "correction" *does not* agree with it.

In no part of his letters does he ever give that formula except as a coefficient, he never gives it merely as mean total pressure ÷ final pressure. But now he omits the word coefficient altogether from his statement of the dispute. At the end of his previous letter, the only place where any reference is made to such an equation, the following is the statement made:

"Thus, instead of $17 - \frac{16}{11^{\frac{1}{3}}} = 3.227$ coefficient, it should be $(17 \times 11^{\frac{1}{3}}) - 16 = 3.75$."

There is here not one word of total pressure divided by final pressure. The statement is that the coefficient is not 3.227, but 3.75. It is not disputed that $(17 \times 11^{\frac{1}{3}}) - 16 = 3.75$; and if it is so, then that will just be the ratio between the mean and the terminal pressures in the case referred to. But the question under discussion is, which is the coefficient of efficiency, the 3.75 or the 3.227. It is 3.227, and 3.75 is not in any sense whatever a coefficient, either of efficiency or of anything else. In the formula he now presents he has altogether omitted the word coefficient, and put in the words final pressure.

He says I have taken the liberty to narrow the question. The statement that the quotation contained "the whole question of the value of the coefficients" is his own, not mine.

There is one part of Mr. Smith's last letter deserving some prominence. "With reference to Mr. Gray's statement that if we have a coefficient 3, that reads that there was given out as available power by the steam not more than three-tenths, or .3 of the power or energy originally stored in it. Now Mr. Gray has no need to assume that a coefficient 3 means anything so meaningless." My statement, that the coefficients introduced by me give not only the relative efficiency in units of the efficiency of non-expansion, but also in decimal parts of the whole energy stored in the steam, was published for the first time in my letter of Nov. 3. I am sure there is no educated engineer who will call it a meaningless expression. It is truly a pearl brought to the surface by that intrepid diver Professor Rankine, and left by him in one of his unopened shells. I picked up the shell, opened it, and found the pearl, and cast it before your readers, and one of them has turned upon me for doing so, and this action explains a great deal of his correspondence. I will now register a prophecy that this "meaningless" statement will live on in engineering science for centuries after we are all forgotten, and if this correspondence results in nothing beyond the publication of this "meaningless" statement, that will of itself amply repay for the time and labour spent upon it, and will justify the appropriation of the great amount of your valuable space that has been given up to it.

I am, Sir, yours most respectfully,

J. MC. F. GRAY.

12, Montenotte, Cork, 4th Dec., 1871.

[We have commented on this correspondence in an article on page 375, of the present number.—ED. E.]

VALVES FOR BLOWING ENGINES.

TO THE EDITOR OF ENGINEERING.

SIR,—In reference to the valves for blowing engines described and illustrated in ENGINEERING of 24th ult., and referred to in the letter signed "Veritas" in your number of 1st inst., it is true that the rubber-covered valves, as applied to the blowing cylinders at Maryport, have proved a failure, but it is not true, as stated by your correspondent, that "the longest time any one of the valves kept in anything like order was only a fortnight," nor that "when blowing two furnaces, only 2½ lb. of blast could be maintained, at a speed of 48 to 50 revolutions per minute of the engines."

When these valves were applied, good results were expected from them, and they were certainly more easy to get at for examination or repair than any other valve in use; provision was, however, made so that they might be replaced by ordinary hinge valves, if the working should not be satisfactory. After the engines had been at work for six or eight weeks, they were stopped for a couple of hours, when I took all the valves out and examined them; some were in very good order, but others were cut and worn by sharp edges on the seatings and guards; it was not possible to stop the engines long enough to remedy this defect in the seatings. New valves were shortly afterwards put in and worked about four months, when they were replaced by the hinge valves. I carefully noted the speed and blast pressure on many occasions during the six months the rubber-covered valves were at work. I need only state what I have myself seen. The *lowest* pressure of blast I observed at any time was 3½ lb. with 36 revolutions of the engines; and on the 6th July, two or three weeks before the valves were finally removed, the speed of the engines was 44 revolutions per minute, and the blast pressure 4½ lb., blowing two furnaces.

The valves were not at any time very tight, but I have every reason to think that this fault will be remedied by a better form of seating, and a more perfect covering of the tubes which form the valves.

I am, Sir, yours respectfully,

WILLIAM INGLIS.

Bolton, December 6, 1871.

TO THE EDITOR OF ENGINEERING.

SIR,—Many a good and really useful invention is condemned for want of a trial, and a still greater number for want of a proper trial or trials.

Messrs. Hargreaves's valves at the Solway Iron Works appear to me (at present at any rate) to have shared such a fate; and your correspondent "Veritas" would benefit your readers infinitely more than he has done at present by giving them fuller details of the said valves and engines, so as to enable them to judge fairly of their merits. What is the use, for instance, of saying that the engines were "coupled, direct acting, and vertical?" and of what use is it to give the number of revolutions of the engines without at the same time giving the length of stroke?

The sentence, "This noise was occasioned by the violent rushing of the air through the small openings, and by the valves dancing on their seats till the succeeding stroke raised them again," partly explains why these valves failed, not necessarily through their construction, but possibly through their relative size and that of the blowing cylinder. If "Veritas" really does mean to give "correct information about the working of these patent valves," then let him give: "Full particulars as to size of valves, and valve openings, amount of lift of valves and weight of same, both for suction and delivery." "Size of blowing cylinder and length of stroke," and "how the india-rubber was secured to the tubes." Also let similar information be given of the new valves that were found to work so well.

Without giving the above or fuller information, it is wrong (to use a mild expression) to condemn a certain construction of valve.

Yours obediently,

JUSTICE.

London, December 4, 1871.

[We quite concur in our correspondent's remarks.—ED. E.]

LARSEN'S PERMANENT WAY FOR TRAMWAYS.

TO THE EDITOR OF ENGINEERING.

SIR,—I am much obliged for your favourable notice of my patents in last week's number, and I shall be glad if you will inform your readers that the heading of the said article should have been "Larsen's Permanent Way for Tramways," as the patent is mine only, that which Mr. Cross has any interest in is the cast chair only. The favour of your correcting this in next number will oblige.

Yours truly,

J. D. LARSEN, C.E.

Greenwich-road, December 4, 1871.

P.S.—My patent is known generally as Larsen's patent, having been in use some considerable time.

CONSTANTINOPLE SUBWAYS.—Contractors have commenced the preliminary works for a new underground communication by tunnel between the lower part of Galata and the Tekè by sinking a shaft on the slope leading from the latter quarter close to the new municipal buildings. The carriages running in this tunnel will be worked on the pneumatic principle, and the fare will be as low as 20 paras per head for each trip. Twenty paras equal 1½d. English.

LIERNUR'S SEWERAGE SYSTEM.

TO THE EDITOR OF ENGINEERING.

SIR,—In your impression of the 2nd November, 1866, there appears an illustrated description of some sewage operations at the Hague. Can you or any of your readers inform me how this has been found to work, and whether the fears expressed by many engineers at the time (that the pipes would become coated with an ever increasing lining of filth) have been altogether groundless?

I have heard vague accounts of what appear to be similar works in other places on the Continent.

Yours truly,

December 6, 1871. C. W.

ADAMSON'S MACHINE FOR FLANGING BOILER PLATES.

TO THE EDITOR OF ENGINEERING.

SIR,—I noticed in your journal of the 1st instant a letter signed "E. Hanson," respecting my improved patented machinery for the manufacture of steam boilers, and a second on the same subject by "Wm. Muir and Co.," of Manchester. The first letter truly admits I paid a royalty of 50*l.* to David Hanson, who had been a workman and foreman of mine. Before ordering the machine which I now work, I had a conversation with the late David Hanson in my own office, when he told me he had not been paid any royalty for his machine then in use, and was not likely to get any. I felt great regret on hearing this statement, and then arranged if I bought or made a machine having a revolving table, I would pay him 50*l.* for what he had done to form flanges on rings for the manufacturing of my patent flange seam flues.

At that time my engineering tools were all fully employed which, in a measure, compelled me to give the machine out. I confidentially consulted "Wm. Muir and Co." as to the manufacture of my improved machine, and contracted with them for the manufacture thereof, with the understanding of using Hanson's revolving table. The acknowledgment of this order by Daniel Adamson and Co. is dated February 8, 1871. My patent is dated February 9, 1871, see specification No. 344. About the middle of April, Wm. Muir and Co., on being pressed to complete the machine, complained that they would lose money by it. To stimulate their operations, and with a view to get the machine quicker, I entered into a further agreement with them, a copy of which I annex:

"21st April, 1871, Manchester.

"D. A. agrees with Wm. Muir and Co. to make them sole makers of patent flanging, turning, and rolling machine, and allow them one quarter of the royalty, or otherwise pay to Wm. Muir and Co. 50*l.* for his or their portion of the trouble in designing the details of the machine, &c.

(Signed) "DANIEL ADAMSON,

"WM. MUIR AND CO."

From this agreement, Mr. Editor, you and the readers of your journal will readily comprehend the utter misrepresentation of the case in Wm. Muir and Co.'s letter, the publication of which will certainly for the future deter myself and probably other inventors from consulting them to carry out their patented inventions either for special tools or other wise. In justice to myself and also to the readers of your journal, I refer you to David Hanson's specification, dated June 5, 1867, No. 1650; and I further have to request, if you possibly can, to publish the late David Hanson's patented machine for flanging boiler plates, that all interested may judge of the two machines in question.

If you, Mr. Editor, will quietly read over the two letters (which appeared in your last issue) again, you cannot fail to discover with me that Mrs. Hanson, with whom I sympathise, has been greatly misadvised in the course she has taken.

I now leave this matter, and remain,

Yours respectfully,

DANIEL ADAMSON.

CONCRETE WHARF AT BATTERSEA.

TO THE EDITOR OF ENGINEERING.

SIR,—Observing in your account of the above that it is assumed to be the first time the method of casting concrete between boards temporarily placed as moulds and afterwards removed as the concrete sets has been resorted to in modern times, permit me to call your attention to other instances where this plan has been used with equal success in structures of much greater extent. The large retaining wall in front of the Marine Parade at Brighton, built by me forty years since, is one. This wall is upwards of 1 mile in length and 70 ft. in height, built precisely in a similar manner, in courses 4 ft. in height, by concrete thrown between planks lodged together, placed on the back and front, and removed as the concrete set. The marks of the mould boards may yet be seen on the face, as described in your account of the ancient structures. This wall I really believe was the first attempt of the kind in modern times, and in ignorance then of it having been used by the Romans.

The Brighton walls have been described and frequently mentioned in descriptions at the Institution, that I am surprised at any one claiming it as anything new. A second and similar wall of nearly equal height and extent was also built a year or two later by me in front of the cliff between the Shakespeare and Abbot's Cliff Tunnels at Dover, when acting as resident engineer under the late Sir William Cubitt, on the South-Eastern Railway, and I have no doubt many other cases could be named.

I am, Sir, your obedient servant,

JOHN WRIGHT, M.I.C.E.

Rochester, December 4, 1871.

[We thank our correspondent for his letter. If he will refer to the article which elicited it, however, he will see that we stated our belief that concrete had not been used before in such a manner as at Battersea, that is, in the construction of a wharf and basement storey for a warehouse, as described by us last week.—ED. E.]

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Glasgow Pig Iron Market.—The Scotch iron trade continues to be animated, and a large business is being done, both for home consumption and for exportation. It is believed that an enormous demand for iron for exportation will arise in the spring, and in some instances makers are at present rather disposed to stock than sell, notwithstanding the high prices which are being given. Towards the end of last month the cash price reached 70s. per ton, it then receded to some extent, but on Friday last the market again became firm, and 70s. 1½d. cash and 70s. 6d. one month were paid. On Monday and yesterday the cash price varied between 70s. 3d. and 70s. 6d., and the month's price between 70s. 9d. and 71s. To-day the market has been steady with prices at 70s. 6d. cash, closing buyers at 70s. 4½d. The makers of special brands have advanced their prices within the last few days. Gartsherrie No. 1 and Coltness No. 1 are quoted respectively at 84s. and 85s.; other quotations are as follows:—Calder 80s., Summerlee and Glengarnock 79s., Shotts and Langloan 78s. The shipments have again shown an increase. Last week they amounted to 15,404 tons as against 12,321 tons in the corresponding week of last year—total since 27th December, 1870, 772,628 tons, as against 691,646 tons in the corresponding period of 1869-70.

The Finished Iron Trade.—In the forges and rolling mills there is still great activity. Within the last few days the principal firms have advanced the price of finished iron 1*l.* per ton. The quotations vary from 9*l.* 15s. to 10*l.* for common bars, the best bars being 10*l.* 10s. Other quotations are, angle irons 10*l.* 5s. to 11*l.*, ship plates 11*l.* 10s. to 12*l.*, boiler plates 11*l.* 10s. to 12*l.* 10s. The foundries are, in most cases, busy, and this is especially true of those firms that work for the marine engines. Pipe founders are generally less busy at this time of the year. It is not unlikely that with the advance just noted in the price of malleable iron, the puddlers and millmen will persevere with their demand for a further advance of wages.

Ship Launches on the Clyde during November.—Since the close of the ship-carpenters' dispute the shipbuilding trade on the Clyde has gone on briskly. The amount of tonnage launched last month was rather over the average, the following being the comparative statement for the month and eleven months:

	Month.		Eleven months.	
	Vessels.	tons.	Vessels.	tons.
1871 ...	12	18,000	156	168,000
1870 ...	17	15,500	173	160,000
1869 ...	20	20,000	200	180,000
1868 ...	13	7,500	192	154,000

Six out of the twelve vessels launched last month had a tonnage varying from 1700 to 3000 tons. There was one sailing vessel of 1500 tons, the others were steamers varying from 900 tons downwards.

Extensive Shipments of Sugar-Making Machinery.—Within the past few days there have been very extensive shipments of sugar-making machinery from Glasgow. To Porto Rico there have been several shipments of a total value of 14,160*l.*; to Java, 260*l.* worth; to Trinidad, 3606*l.* worth; to Jamaica, 250*l.* worth; to Brazil, 320*l.* worth; to Matanzas, 760*l.* worth.

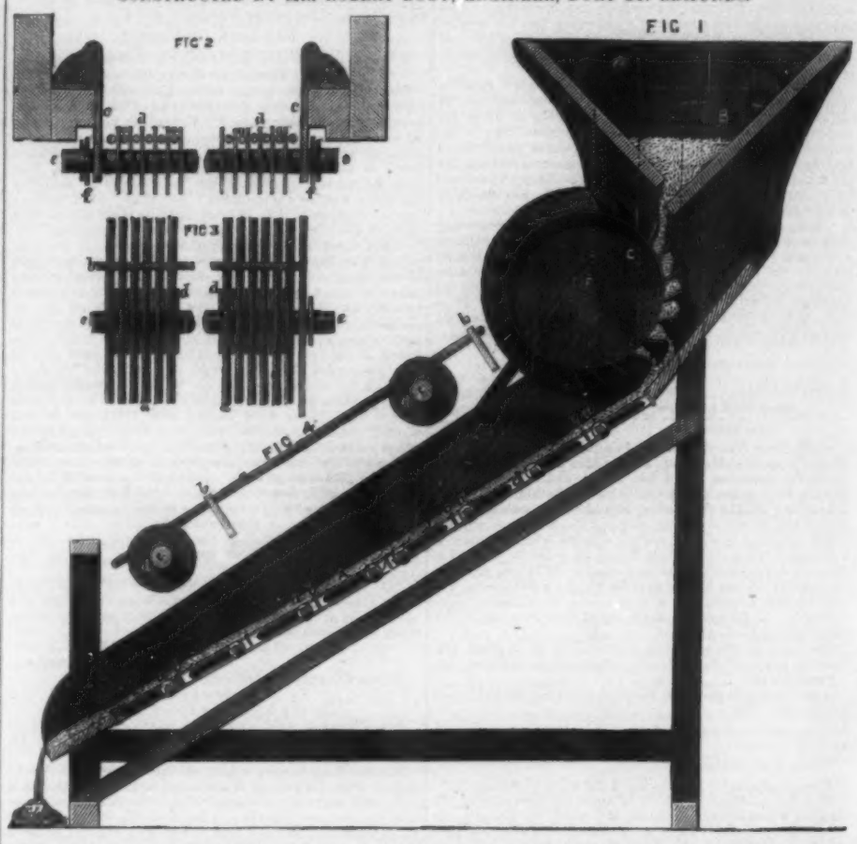
Shipments of Sewing Machines and Steam-Ploughing Machinery.—There have recently been shipped from Glasgow two large consignments of sewing machines—one, valued at 1000*l.*, to Havre, and the other, valued at 2700*l.*, to Melbourne. The manufacture of these machines is now carried on in Glasgow on an extensive scale. Several shipments of steam-ploughing machinery have lately been made from Glasgow to the West Indies, the latest being a consignment of 60½ tons to Trinidad, and of the value of 2560*l.*

Edinburgh and Leith Engineers' Society.—At the last meeting of this society, a paper was read by Mr. Hugh C. Bell, C.E., on "Tramways," the causes which have led to their adoption, their construction, and cost, and the likelihood of their proving remunerative. In the course of his paper, Mr. Bell exhibited in detail, by the assistance of diagrams, the different methods of tramway construction adopted in Edinburgh, Glasgow, London, and Liverpool, contrasting them with each other as regards prime cost and facility of maintenance. Mention was also made of a new system of tramway at present employed on Glasgow quays, its peculiarity being that no timber is required for its construction.

Engineering Society, King's College.—At a general meeting of this Society held on Friday, 1st December, Mr. Hunter, President, in the chair, a paper was read by Mr. W. M. Vivian, on "Naval Architecture" with reference to the past, present, and future, of the royal and mercantile navies. Mr. Vivian commenced by describing the form of ship best suited for coast defence, after which he mentioned the points to be attended to in designing a sea-going ship of war together with the difficulties to be encountered in so locating the large mass of iron in the plating as not to destroy stability; passing on to describe the tendency in the present day to increase the size of guns and weight of armour in ships for coast service, and to lighten armament and guns, thereby increasing the speed of sea-going cruisers, trusting more to steam than to powder, using the former as a means of defence by ramming. The author next said a little on the effects of the Suez Canal on mercantile naval architecture, that is a tendency to increase the size and number of steam vessels, the increase of size being in length and breadth of beam, the depth remaining the same, that the vessels may, with less difficulty, navigate the shoal waters of the Red Sea. At the close of the paper, a discussion ensued with reference to the coal carrying capacity of steamships, &c. The proceedings then terminated.

SELF-CLEANING CORN SCREEN.

CONSTRUCTED BY MR. ROBERT BOBY, ENGINEER, BURY ST. EDMUNDS.



In the course of our account of the meeting of the Royal Agricultural Society, at Wolverhampton, in July last, we had occasion to mention a neat arrangement of self-acting corn screen designed by Mr. Robert Boby, of Bury St. Edmunds; and of this screen, which is also exhibited at the present Smithfield Show, we now annex illustrations. Referring to the engravings it will be seen that the grid, A, of the screen is fixed at a suitable inclination, and is connected at its upper end with a hopper, B; this hopper being supplied by an elevator or otherwise with the corn to be screened. This corn is delivered on to the grid, A, through the intervention of a bucket wheel, C, for the purpose, which we shall proceed to explain.

Fig. 2 is a part plan, and Fig. 3 a cross section on an enlarged scale, of the grid with the clearing arrangement applied to it, and Fig. 4 is a corresponding longitudinal section. The grid consists of a series of longitudinal, parallel, round, or other shaped rods, *a*, held together by being passed through holes or notches formed in transverse bars, *b*, to receive them, these bars being secured at their ends to side pieces, *c*. Between the longitudinal parallel rods, *a*, of the grid are inserted small discs or projecting pieces, *d*, which are intended to traverse the spaces between the longitudinal rods and the transverse bars, *b*, for the purpose of keeping the spaces open. These discs or projections are carried by transverse rods, *e*, fitted to side bars, *f*, that slide over the sides, *c*, of the fixed screen, the sides of the screen being slotted, as shown at Fig. 1, to allow of this traverse motion of the rods and to form guides for those rods.

Pivotted to the side bars, *f*, on either side of the screen is a pair of crank rods, D, which connect with double-throw cranks, E, carried by a transverse shaft, F, mounted in bearings in the side framing of the machine. This shaft, F, forms the axle of the bucket wheel, C, which is keyed fast to its axle. This bucket wheel is so situated with respect to the hopper and the grid, as to receive the corn as it falls from the hopper and deliver it on to the grid. The weight of the stream of falling grain serves to give to the bucket wheel a rotary motion, which motion is communicated through the cranks, E, and crank rods, D, to the sliding bars, F, that connect the rods of the screen clearers together, and thus an automatic traverse motion is given to the screen clearers through the descent of the corn from the elevated hopper. The arrangement is a very simple one and seems to answer its purpose well.

Proposed Neva and Gulf of Finland Canal.—A gigantic scheme for establishing a new port at the mouth of the Neva has been designed by M. Putiloff, the noted iron manufacturer, the details of which are given by the Moscow correspondent of the *Levant Herald*. The plan is briefly as follows: To open a passage for goods direct from the Upper Neva to the Gulf of Finland without transshipment by cutting a canal 12 miles in length from Alexandrovski (some distance above the capital) to M. Putiloff's factory, on the shore of the Gulf beside Volni Island. To construct a harbour at this battery point, traversed by a custom-house quay 2 miles in length, and containing three basins—one for outward-bound shipping, another for vessels arriving from abroad, and a third for lighters, as also a floating dock for repairs. To cut a canal through the Gulf in the direction of Cronstadt from the extremity of the harbour (where the water is 12 ft. deep) to the 18 ft. level, a distance of nearly 4 English miles. To lay a railway parallel, or nearly so, with the overland canal, from Alexandrovski to the Putiloff factory, and thence in three branches along the Custom House quay and the outer embankments to the extremity of the new harbour, connecting itself *en route* with the Moscow, Tsarskoe-Celo, Warsaw, and Peterhoff railways, and also with the Alexandrovski mechanical works and the great warehouses at the mouth of the Obvodni Canal. According to the prospectus issued by M. Putiloff, the harbour works are to include two quays, three sets of warehouses, a custom-house, an hotel for the reception of passengers, a complete apparatus of cranes, &c., for the loading and unloading of goods, a system of gas, and a quenching apparatus in case of fire.

London Association of Foremen Engineers and Draughtsmen.—The ordinary monthly meeting was held on Saturday last at the City Terminus Hotel, and the attendance of members was very large. Mr. Joseph Newton, Royal Mint, president, occupied the chair, and as usual the election and nomination of new associates constituted the first business of the sitting. Mr. Smithies, of Upper Thames-street, was unanimously elected as of the honorary class, and Messrs. W. Virtue, E. W. Ives (draughtsman), and J. E. Weaver, were added to the ordinary class. Mr. Hugh Gray was also nominated for the latter position. The twentieth anniversary of the institution will be observed at the City Terminus Hotel on the third Saturday in February next. Mr. Thomas Haughton (manager for Messrs. Turner and Co., East-street, Manchester-square) then read a paper on the "Machinery used in the Manufacture of Cloth." Towards the elucidation of his subject—which was treated of in a thoroughly practical and technically correct manner—Messrs. Tatham (Rochdale), Messrs. Leach (Leeds), Messrs. J. Sykes and Sons (Huddersfield), Messrs. G. Wailes and Co. (Stroud), Messrs. Knowles, Houghton, and Co. (Leeds), assisted Mr. Haughton materially by furnishing numerous photographs, drawings, and models. The paper was listened to with great interest, and a discussion followed it, in which Messrs. Briggs, Galloway, Nicholson, Ives, the chairman, and others, shared. The proceedings closed with a vote of thanks to the author of the paper.

THE OTAGO GREAT NORTHERN MAIN TRUNK RAILWAY.

BRANCH LINE TO PORT MOERAKI.

BRIDGE OVER THE RIVER WAITAKI, MR. J. MILLAR, ENGINEER.

WE have selected for publication two views which will serve to illustrate some of the most interesting features of the Otago Great Northern Trunk Railway—an undertaking which will have a length of 222 miles—and will extend from Dunedin, the capital of the province of Otago, to Christchurch, the capital of the province of Canterbury.

The line leaving Dunedin would pass through the Moeraki district, and through the town of Hampden, where there would be a station. It would afterwards cross the southern branches of the Waianakarua river, on a high-level viaduct erected upon an existing stone bridge, and traversing the mountain gorges of the northern Waianakarua river, would again cross the stream by a bridge 110 ft. above the water level. At this point the level of the railway is 108 ft. lower than the coach road 70 chains away. After passing through the district of Oamaru the railway enters the town of that name, where a commodious station would be built. Continuing northwards the line arrives at the river Waitaiki, which separates Dunedin province from that of Canterbury.

There would be several branches to this railway, one running eastward to the Kakanui quarries and some meat curing establishment; another leaving the main line at the town of Oamaru, and also running to some rich quarries; a third communicating with the Maruwenua goldfields, and a fourth going to Port Moeraki.

The first sketch shows Moeraki bay with a branch from the main line sweeping around the coast to the port of embarkation, where a wharf will be constructed probably on screw piles, with a lighthouse at the end. The railway will form a loop around this, having a radius sufficient for the passage of a double bogie engine and suitable rolling stock. Moeraki is a good port, probably the best in the South Pacific. It is quite sheltered from the south-east winds, and indeed is only exposed to the north-east, from which quarter, however, the prevailing winds do not set. But although this bay is well situated, and possesses many natural advantages, the greatest amount of traffic will be directed to Port Chalmers, seven miles from Dunedin, and with which the Trunk Railway will communicate.

The second illustration shows the proposed bridge over the Waitaki river, which will carry the trunk line into the province of Canterbury. The bridge as designed would consist of 28 bays, each of 182 ft. from centre to centre of piers. On the Canterbury side an extra span of 45 ft. would lead the general traffic upon the bridge, as shown, the rail level being on the top, and the road level at the bottom of the Warren girders which would compose the structure. The river, which is in times of low water reduced so much in volume that the bed is exposed in banks of shingle, as shown in the sketch, is greatly flooded at the season when the snow melts from the mountains, and passes down in torrents. At such times the width of the river is increased to a mile, and the water rises to a level within 5 ft. of the proposed level of the bridge. We are indebted for the photographs from which these drawings are taken to Mr. J. Millar, civil engineer, of Dunedin, who has prepared all the plans embodied generally in the illustrations.

JOHN COCKERILL OF SERAING.—The town of Seraing, near Liège, in Belgium, contains 25,000 inhabitants, all dependent on the great iron smelting and engine making works of Messrs. John Cockerill and Co., which employ 8000 persons, in the iron mines, coal pits, foundry, and machine factory, earning average wages of 3 francs to 3 francs 20 cents a day. These great works owe their establishment to Mr. John Cockerill, the son of a working man, who left England and settled at Verviers towards the end of last century. After the peace of 1814, he purchased the estate and palace of the Prince Bishop of Liège, at Seraing; and, being joined by the late King of Holland, then King of the Netherlands, as a partner in trade, set up this business, which was soon developed to an enormous extent. Mr. John Cockerill's partnership with the King of the Netherlands was dissolved by the Belgian Revolution of 1830. He sustained heavy losses in 1839, and died in the same year. The business is now carried on by a limited liability company, in the name of John Cockerill and Co. A fine statue of Mr. Cockerill has been erected, more than thirty years after his death, at the cost of the town of Seraing. The sculptor is a Belgian artist, M. Gattier. Another statue of Mr. Cockerill is to be erected at Brussels, the gift of his friend, M. Raux.—*Illustrated London News.*

WINDING ENGINES.

We publish this week a two-page engraving showing a side elevation of a very fine pair of winding engines constructed by Messrs. John Musgrave and Sons, of the Globe Iron Works, Bolton, Lancashire, from the designs of Mr. James Barrows, consulting engineer, Wigan, and erected by them at the Skelton Iron Mine, Saltburn-by-the-Sea, for Messrs. Bolckow, Vaughan, and Co. (Limited). We also give on page 368 an end view of these engines, and next week we intend to complete our illustrations by publishing a corresponding ground plan.

The engines have cylinders 36 in. in diameter with 6 ft. stroke, and are fitted with Cornish valves worked by tappets, as shown in the side elevation. The tappets are actuated by eccentrics through the intervention of reversing gear of the stationary link class, the reversing shaft being placed beneath the foundation plates and extending to the outside of the left-hand engine under the engineer's platform, where there is placed the reversing lever and also the handles and shafts for working the steam brake and stop valves. The eccentrics of each engine are not placed on the winding drum shaft but on a special countershaft driven by a crank at its end, taking hold of the main crank pin, as shown in the side elevation.

The winding drum is a compensating one, conical in form, and having three sets of arms and segments with lags of the best Georgia pine. The maximum diameter of the drum is 22 ft. and its minimum diameter 18 ft., there being on each side a spiral groove for a round rope to wind from a depth of about 100 fathoms.

The middle sections of the winding drum form a brake ring 22 ft. in diameter by 8 in. wide, and to this ring a brake strap is fitted, as shown in the side elevation, the strap clipping the ring for about one-third of its circumference. At one end the brake strap is connected by an adjusting screw to a stirrup hanging from a strong wooden beam which spans the drum pit as shown, while at the other end it is attached by a link to a lever having its fulcrum on a shaft arranged, as shown, just below the level of the foundation plates. This lever, of which the arms are in the proportion of about 7 to 1, extends downwards, and its lower end is coupled by links to the piston rod of a steam cylinder 10 in. in diameter and 3 ft. stroke, fixed horizontally on wooden beams built into the engine foundation as shown in the side and end elevations. The slide valve, by means of which the steam can be admitted to, or released from, either end of the brake cylinder is worked by a rod extending to a handle conveniently placed on the engineer's platform.

In addition to the arrangements for working the brake by steam, provision is also made for applying it by hand if necessary. For this purpose the link which couples the brake strap to the steam-worked lever is made with a slot in it, through which there passes a pin, connecting it to a short lever fixed on a shaft, as shown in the side elevation, this shaft extending laterally to beneath the engineman's platform. Here there is fixed upon it a long lever, carrying at its end a nut, through which there passes a screw actuated by a hand wheel, as shown. Thus by turning the screw and forcing down the end of the long lever the brake can be applied without using the steam cylinder for the purpose, while on the other hand the slot in the link at the end of the brake strap—through which the pin coupling it to the hand lever passes—is sufficiently long to allow of the brake being applied by steam without interfering with the hand-worked arrangement.

Altogether the whole of the details are well worked out, and the engines are very fine specimens of their class, doing credit alike to their designer and builders.

NOTES FROM THE SOUTH-WEST.

Llynamlet Tin-plate Company.—On Saturday afternoon the Llanamlet Tin-plate Company, Morriston, started two new rolling mills. A fine condensing engine manufactured by the Millbrook Iron Company, Landore, was set in motion. The first bar was rolled out by the manager, Mr. William Williams. The turn-out of finished plates from these works will shortly amount to from 1500 to 1800 boxes per week.

The Port of Cardiff.—The exports of coal to foreign ports from Cardiff in November were 218,878 tons. The following ports figured in this aggregate for 5000 tons and upwards each:—Barcelona, 6356 tons; Constantinople, 5196 tons; Gibraltar, 6328 tons; Genoa, 7738 tons; Havannah, 8443 tons; Havre, 10,438 tons; Malta, 13,962 tons; Monte Video, 5046 tons; Odessa, 11,436 tons; Port Said, 5025 tons; Rio de Janeiro, 13,040 tons; St. Nazaire, 22,176 tons. The quantity of coal exported coastwise from Cardiff in November was 79,928 tons. The iron exported from Cardiff in November attained an aggregate of 17,827 tons; in this total New Orleans figured for 2823 tons; New York, for 4574 tons; and Rotterdam, for 2806 tons. Patent fuel was exported from Cardiff in November to the aggregate extent of 6470 tons, of which 3340 tons went to Aden.

Newport Alexandra Dock.—The quay walls of this dock are being constructed of a fine stone cut from Lord Tredegar's quarry at Nine Mile Point on the Western Valley Railway. Some idea of the extent of this quarry may be formed from the fact that large blocks have within the last week or ten days been cut out weighing 114, 170, and 200 tons respectively. After these massive blocks are cut out of the quarry, they are divided into a number of smaller ones weighing on an average 5 or 6 tons each, and they are then despatched by the Monmouthshire Railway to the neighbourhood of the dock.

Iron for the United States.—The Pauline has cleared from Cardiff for Galveston with 620 tons of railway iron supplied by the Aberdare Iron Company. The Ebenezer has cleared from Newport for New Orleans with 697 tons of iron supplied by the Blaenavon Iron Company. The Imperator has cleared from Cardiff for New Orleans with 800 tons of railway iron supplied by Messrs. Guest and Co. The Mermaid has cleared from Cardiff for Mobile with 992 tons of railway iron supplied by the Rhymney Iron Company.

The Welsh Iron Trade.—It is stated that the furnaces built by Mr. F. Crawshay, at Treforest, Glamorganshire, will shortly be re-lighted and in full work. At the Race Works, Pontypool, the Ebbw Vale Company has also been extending its operations, another furnace having been put in blast. The Blaenavon Iron and Steel Company has been building another furnace, which will give employment to a considerable number of additional work people.

Newport and Pillgwenlly Water Works.—The Newport and Pillgwenlly Water Works Company will apply to Parliament next session for powers to obtain an increased supply of water. The spot from which the company hopes to obtain this increased supply is in the neighbourhood of Risca. By the company's new arrangements the water supply of Newport will be secured by gravitation.

Llynvi and Ogmore Railway.—The directors of the Llynvi and Ogmore Railway Company propose to apply to Parliament next session for powers to divert a portion of the Porthcawl branch, and to construct instead a line from Pyle to Newton Nottage. They will also solicit an extension of time for the completion of authorised works.

South Midland Railway.—The plans deposited with reference to this proposed railway show that it is an undertaking of considerable extent and importance. The length of the through line from Lydney to Andover is 74 miles, and side lines make up a total of 113 miles. Sixteen tunnels are contemplated, of an aggregate length of 8¼ miles, and a river bridge at Sharpness, will be 1351 yards long; it will be carried on 33 spans, two of which will be 300 ft. wide and 70 ft. high. It seems doubtful, however, whether an enterprise of such magnitude will be carried out.

Great Western Railway.—The directors of the Great Western Railway are going to Parliament for powers to acquire the Swansea Canal navigation, and also the Duke of Beaufort's Treweyddfa Canal. They propose to connect the Swansea branch of the Great Western with the Swansea Vale Railway. The arrangements contemplated comprise the erection of a new station at Swansea.

Monmouthshire Steam Coal.—At the last quarterly meeting of the Newport Chamber of Commerce, Mr. Bladon stated that the Ebbw Vale Company had had an application to tender for the supply of steam coal to the Government. The eligibility of Monmouthshire steam coal was thus, Mr. Bladon observed, now recognised. The chairman observed that he had no doubt that Monmouthshire steam coal would be more used as it became known. Mr. S. Batchelor said he believed that the Admiralty list had been done away with, and that no such thing as preference now existed with regard to steam coal.

The Nine Hours' System.—The nine hours' system has made further progress at Gloucester. Messrs. Eassie and Co., who will be remembered as having supplied huts for the French and English troops during the Crimean war, have adopted the system without solicitation. Messrs. Kell, iron-founders and agricultural implement manufacturers, have followed a similar course.

Western Junction Railway.—This project, which was for a line west from Gatcombe to Lydney, another east from Gatcombe to Awre, a bridge from Gatcombe to Pinton, a branch to the new docks, and an extension line to Pilning, appears—according to the plans deposited—without the latter extension, which was one of its chief features. It seems that one night recently, soon after midnight, several engineers left Lydney in boats, crossed the river, and landed one detachment at Pinton, and a second at Sharpness, while a third approached by road and rail. They bivouacked that night, and as soon as daylight appeared they commenced surveying. But they were quickly set upon by the natives, assaulted severely, and their instruments broken and taken from them. One of the party is said to have been severely hurt, and it is stated that the whole matter will form the subject of legal inquiry.

State of Trade at Newport.—There is not much change to report in the state of business at Newport. Considerable coal shipments have been made to the West Indies, the Mediterranean, and the Brazils. A large English steamer has been taking in a cargo of rails for Alexandria. Shipments of iron have also been made to Vera Cruz and Baltimore.

Taff Vale Railway.—The revenue of this system continues to increase. At the same time, there will be a sensible falling off in the receipts for the whole half-year.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a larger attendance on 'Change at Middlesbrough than there has been for several market days. In no time during the past year has the iron trade been so good as it is at present. As we foreshadowed last week, the quotations yesterday were a shade higher. The price of No. 3 is now 61s., and some makers are quoting as much as 62s. per ton. Most of the smelters have now a great many heavy contracts for next year. Although the production of pig iron is so large, it is still unequal to the demand. The shipping season having closed, makers are doing their utmost to make up the arrears they have fallen into with their home contracts.

The Returns.—Connected with the Cleveland Ironmasters' Association there are now 132 blast furnaces, 125 of which are in blast. The fact that the make in November is 2700 tons less than in the previous month is accounted for by the scarcity of coal, occasioned by a dispute respecting the hours of labour at some of the collieries in Durham.

The New Works.—The work of extension is going on very rapidly on Tees-side. The Lackenby Iron Company, Middlesbrough, are building a new blast furnace; Cochrane and Co., Middlesbrough, are building a new furnace; Gjers, Mills, and Co., Middlesbrough, are building two new furnaces; D. Samuelson and Co., Middlesbrough, are building one new furnace; the Consett Iron Company, Consett, are building one new furnace; the North of England Industrial Iron Company are building one new furnace; and the Rosedale and Ferry Hill Iron Company are building two new furnaces. Many of these furnaces are considerably advanced towards completion. New companies have recently been formed for the erection of blast furnaces—notably, the Marton Iron Company, who have procured a site near Coutham, and the Tees Bridge Company, who have actually commenced with the foundations for two furnaces in Bowesfield, Stockton.

The Finished Iron Trade.—Like the pig trade the finished iron trade continues in a thoroughly satisfactory condition. In all departments there is plenty of work, and the prospects are most cheering. The railway requirements will be enormous next year, and from the inquiries which have already come to Cleveland makers, it is certain that large contracts will be secured in this district. The plate mills are sure to be kept busy for many months to come in consequence of the extraordinary demand for steamers of all sizes.

Puddling by Machinery.—We learn that the Commissioners sent out to America to test the working of Danks's puddling furnace have communicated to the Iron and Steel Institute additional information confirming their telegram that the furnace was a success. It is now certain that Danks's furnaces will be erected in this country at an early date, and it is equally certain that a revolution in this branch of the iron trade is at hand.

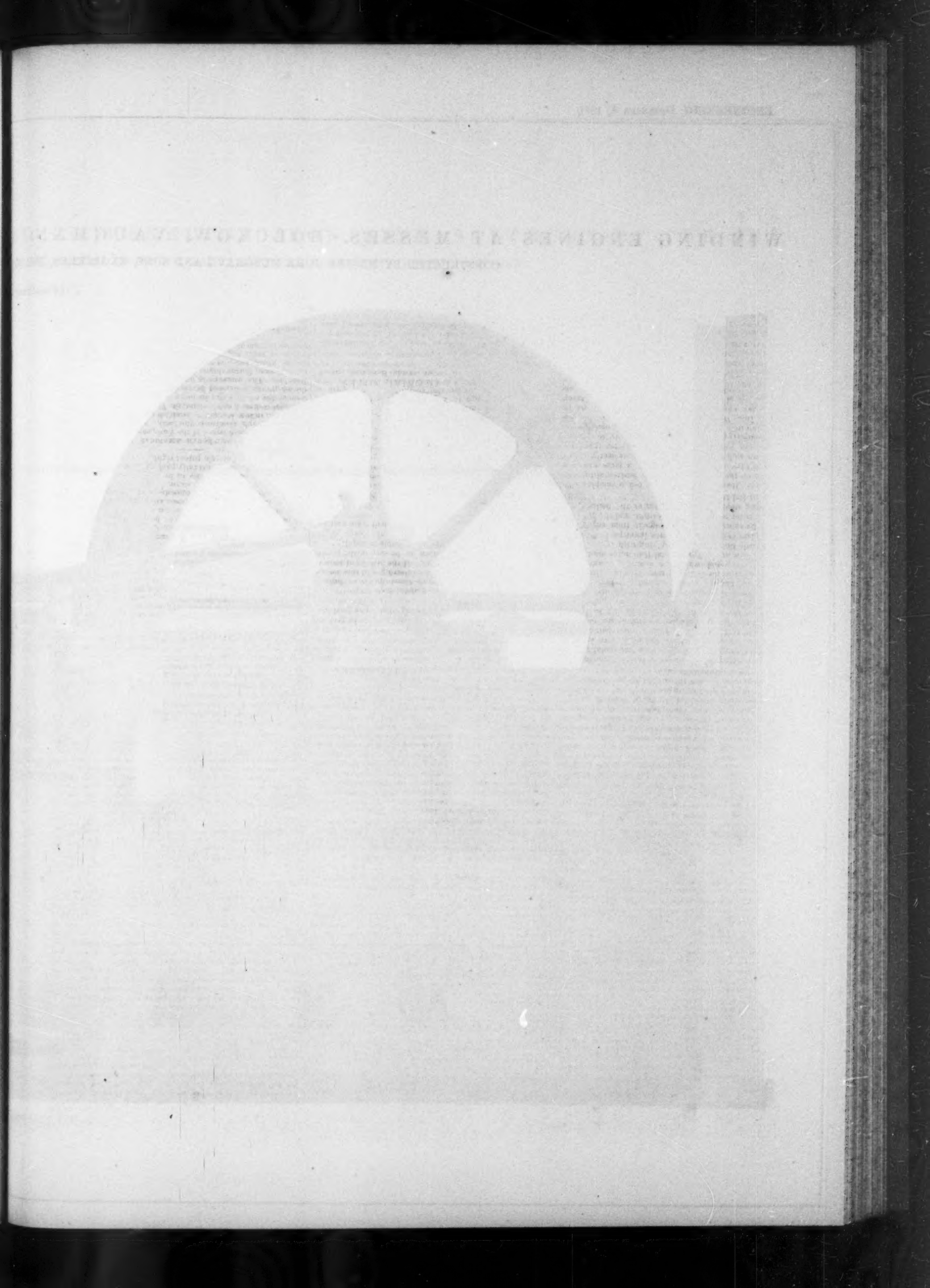
Engineering.—Engineers generally throughout the North of England are busy. There is a fair amount of locomotive work on hand, and bridge-building is better. The marine engine builders have their order books well lined, and will be kept fully engaged for the greater part of the coming year.

The River Tyne.—It is stated that the honour of knighthood has been offered to the chairman of the River Tyne Commission, Mr. Alderman Cowen, M.P. During that gentleman's presidency, the Commission have made the Tyne one of the greatest ports in the United Kingdom, and they still have on hand improvements, the making of which will involve the outlay of immense sums of money.

The River Tees.—An important arbitration case is being heard at the Tees Conservancy Offices this week. Under the able management of the Tees Conservancy Commissioners many hundreds of acres of land in the lower reaches of that river have been reclaimed, and, according to Act of Parliament, the owners of the foreshore have the first offer if they desire to purchase any part of this land. The object of the arbitration is to fix the price at which the land-owners alluded to may purchase the land. No doubt when this question is settled, large quantities of this land will be in the market for commercial purposes.

The Mines.—In Northumberland, Durham, and Yorkshire the collieries generally are working satisfactorily now. The demand for coals is heavier than ever, and prices are fully maintained. Best coke is in great request, and realises good prices. Cumberland hematites are selling well. Throughout Cleveland the ironstone mines are being admirably worked out. Extensions are going on all over the mining districts.

The Institution of Civil Engineers.—At the meeting of this society on Tuesday, Dec. 5, 1871, Mr. Joseph Cubitt, Vice-President, in the chair, the first monthly ballot for the present session was taken, and resulted in the election of two members—viz., Mr. Ernest Benedict, Chief Engineer in India of the Eastern Bengal Railway; and Mr. Mark Hyde, Manchester; and of twenty-eight associates—viz., Mr. Henry Adams, Stud. Inst. C.E., Arundel-square; Mr. Edwin Clerk Allam, Romford; Mr. Emerson Bainbridge, Stud. Inst. C.E., Manager of the Nunnery Collieries, Sheffield; Mr. William Borrer, Horsham; [Major James Browne, R.E., Ex. Eng., P.W.D., India; Major Joseph Smith Bryce, New York; Mr. Henry Carter, Stud. Inst., C.E., Westminster; Mr. Octavus Deacon Clark, late Acting District Engineer, G.I.P. Railway; Captain Henry Doveton, R.E., late Assistant Consulting Engineer for Railways, Government of India; Mr. Barrow Emanuel, M.A., Finsbury-circus; Mr. Walter Combermere Lee Floyd, late Engineering Staff of the G.I.P. Railway; Mr. Joseph Rake Harding, Engineer and Surveyor to the Epsom Local Board of Health; Mr. John Jurd, Southampton; Mr. Edward Tiley Lambert, B.A., Surbiton; Mr. Edward John Lloyd, Resident Engineer of the Warwick and Birmingham, and Birmingham and Warwick Junction, and other canals; Mr. Philip Edward Murphy, Brompton, Kent; Mr. Robert Augustus Oldham, Ex. Eng. P.W.D., India; Mr. Christopher Pattison, Naples; Mr. George Pullin Pocock, Stud. Inst. C.E., Inverness-terrace; Mr. Thomas Tennison Ryan, Ex. Eng., P.W.D., India; Mr. William Heron Steel, P.W.D., Melbourne; Mr. Frederick William Stevens, Assist., Eng. P.W.D., India; Major Richard Hugh Stotherd, R.E., Chatham; Mr. James Strachan, Resident Engineer, G.I.P. Railway; Mr. Arthur Smith Truman, Lisbon; Mr. William Walton Williams, jun., Stud. Inst. C.E., Madrid; Mr. George Walter Winckler, Assist. Eng., Hoobleo and Carwar (State) Railway, India; and Mr. Alfred Hope Wood, Hastings. The Council reported that during the present session, acting under the provisions of Sect. III., Clause 7, of the Bye-Laws, they had transferred Messrs. Harry Pasley Higginson, Alexander McKerrow, John Birch Paddon, and William Henry Preece, from the class of associate to that of member; also that, in accordance with Sect. IV., they had admitted the following candidates Students of the Institution:—Messrs. William Syson Cundy, Harry Dancer, George Edmund Doorly, James Graham Doorly, Alan Grant-Dalton, George Jessop, William Stronach Lockhart, John Christie Mackay, Alexander William Meeve, Alfred Eley Preston, Alphonso Raymond, Cecil Scott, and William Kitson Stent.



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CONSTRUCTED BY MESSRS. JOHN MUSGRAVE AND SONS, ENGINEERS, BOLTO

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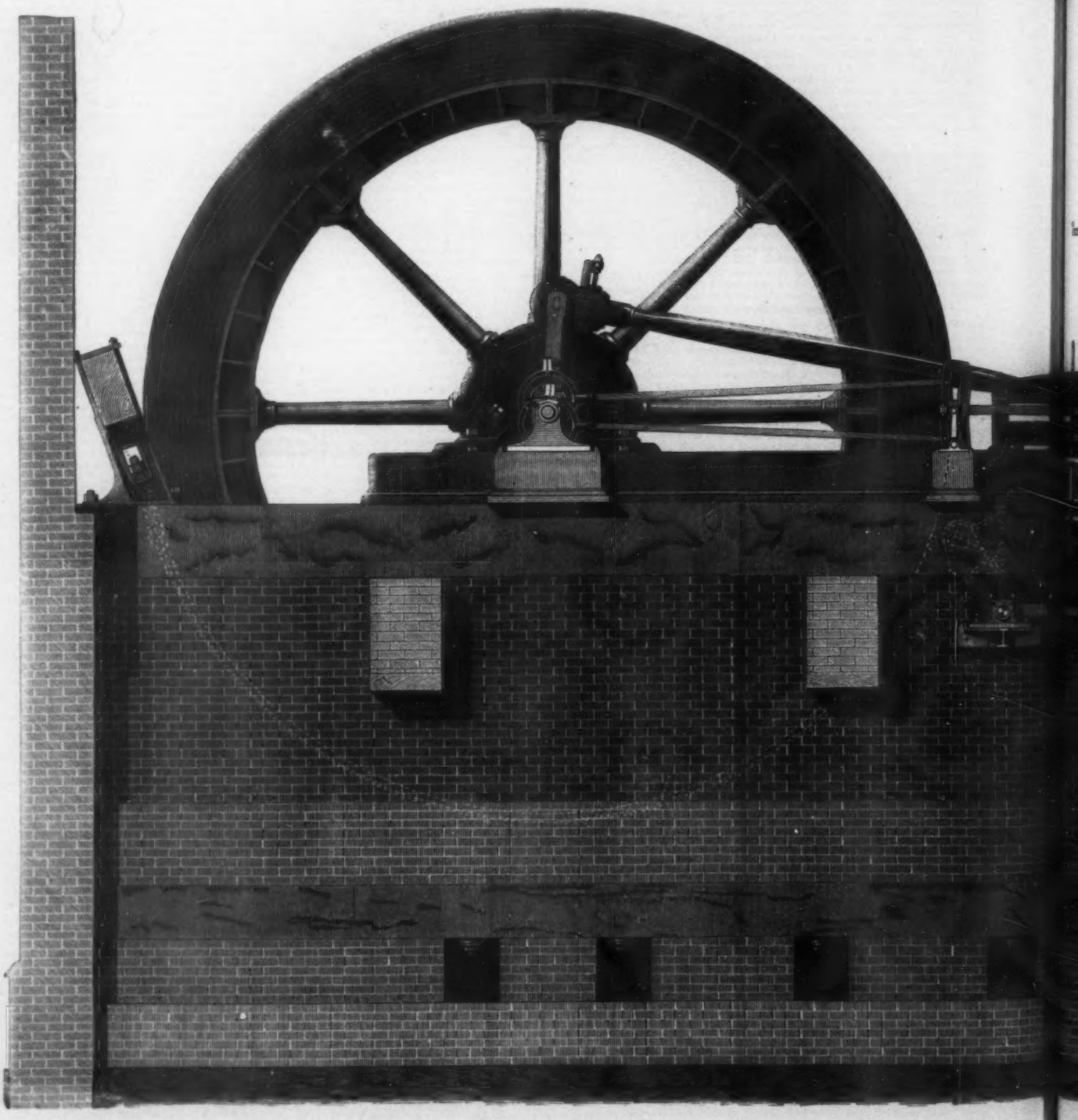
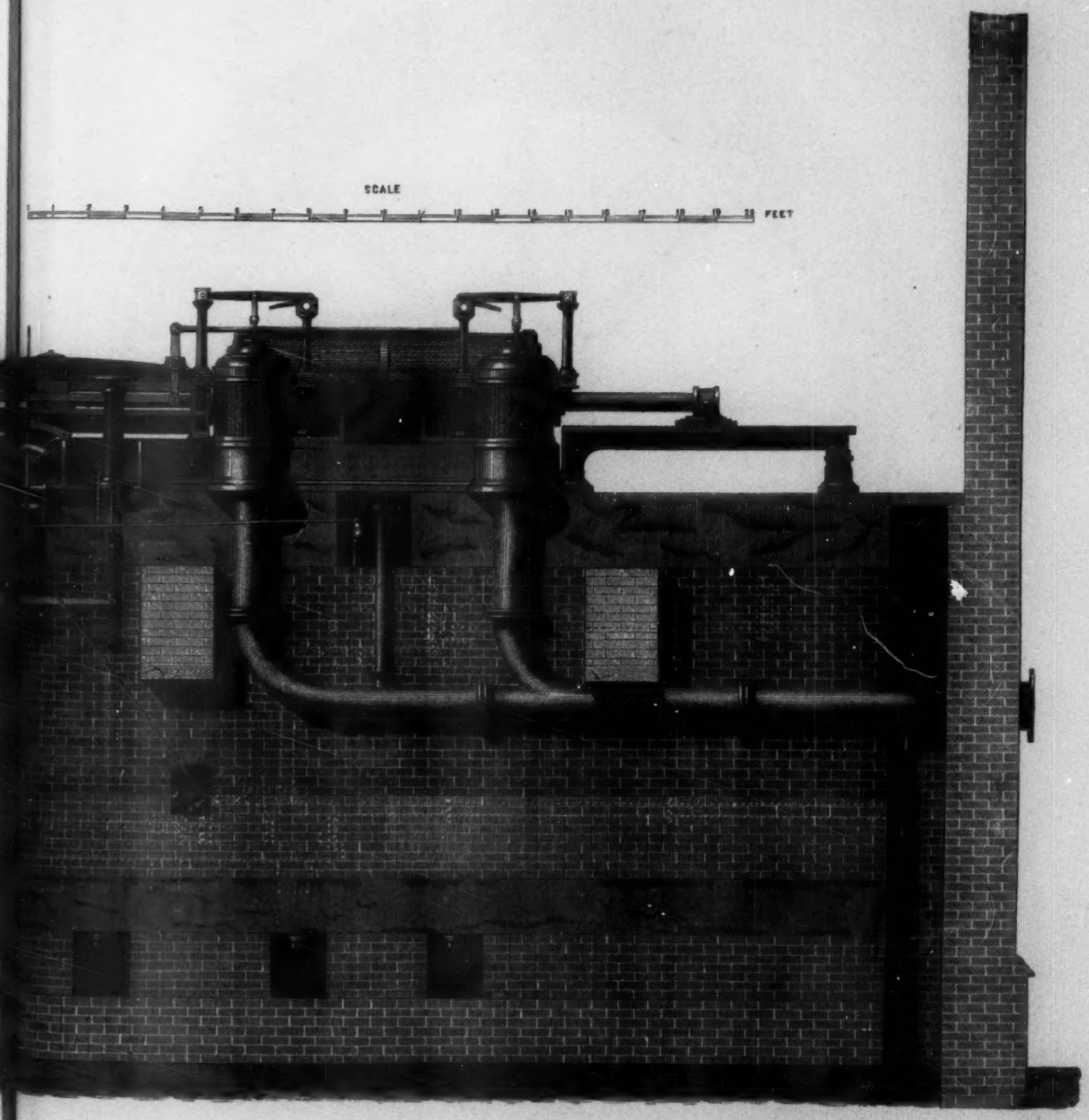


ND CO.'S SKELTON IRON MINE, SALTBURN-BY-THE-SEA.

TO FROM THE DESIGNS OF MR. JAMES BURROWS, CONSULTING ENGINEER, WIGAN.

Page 374.)



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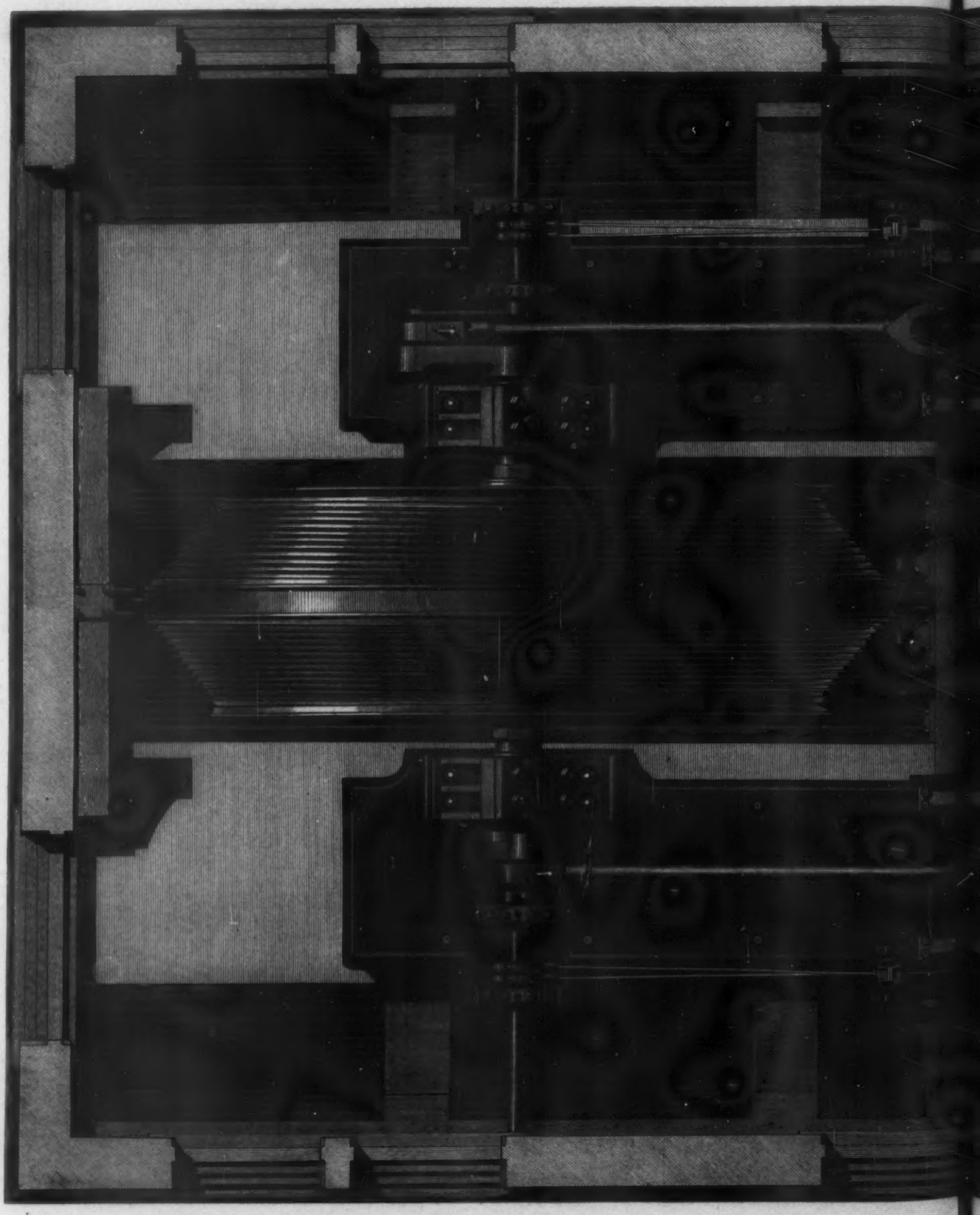

D CO.'S SKELTON IRON MINE, SALTBURN-BY-THE-SEA.

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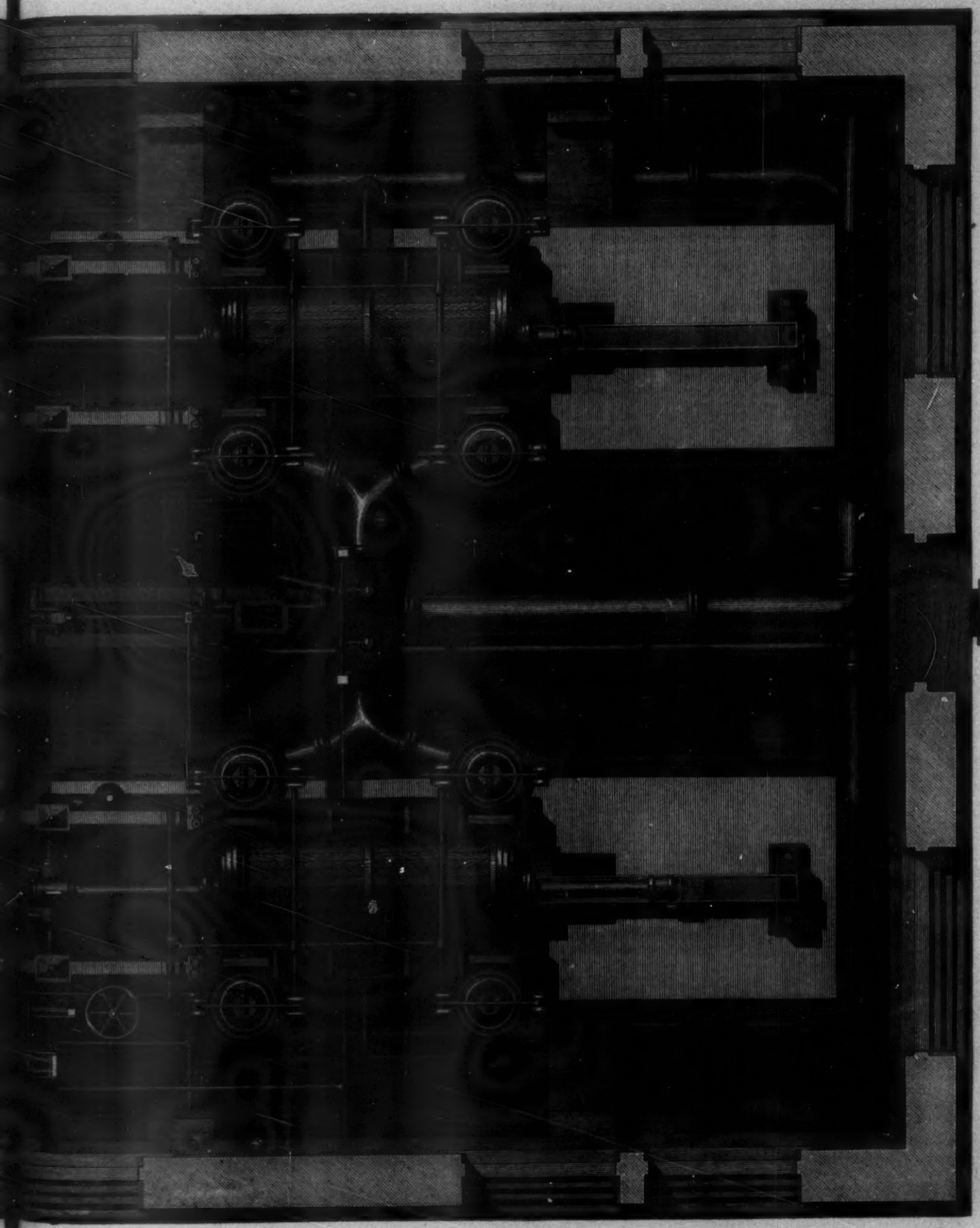

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NOTICE OF MEETING.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 12, at 8 p.m. 1. Discussion on the "Stresses of Rigid Arches." 2. "The Somerset Dock, Malta." By Mr. Charles Andrews, M. Inst. C.E.

THE "ENGINEERING" DIRECTORY is published this week on the thirteenth page of our advertisement sheet.

NOTICE TO AMERICAN SUBSCRIBERS.

In consequence of the great increase in our American connexion, we have found it necessary to establish a branch office in the United States. Communications may in future be addressed to MR. GEORGE EDWARD HARDING, C.E., *of* 176, *Broadway, New York, who is our accredited representative.*

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of* 1*l.* 14*s.* 8*d.* ($8.32, *gold*) *per annum, payable in advance.*

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ENGINEERING.

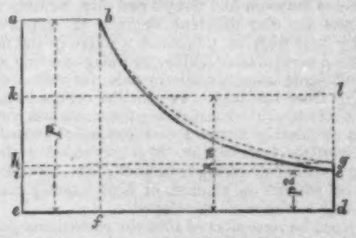
FRIDAY, DECEMBER 8, 1871.

STEAM ENGINE COEFFICIENTS.

DURING the past few weeks there has been carried on in this journal an energetic discussion on the subject of steam engine coefficients, and this discussion has, we consider, reached a stage at which it is desirable that we should summarise the arguments on both sides, and point out as clearly as we can the points of difference and their bearings on the case. The discussion originated, as most of our readers are no doubt aware, from the publication in our number of September 15th last, of a series of coefficients calculated from indicator diagrams taken from some compound marine engines constructed at the Hartlepool Iron Works, from the designs of Mr. Charles Smith, the manager of those works. These coefficients were calculated according to a system largely used by the late Mr. John Elder,* namely, by dividing the mean effective pressure (all referred to the large cylinders) deduced from the indicator cards, by the final total pressure in the large cylinders; and they were given as 3.18, 3.32, and 3.35 respectively, the three different coefficients being deduced from three sets of indicator diagrams taken under different circumstances. In our number of the week following, there appeared a letter from Mr. J. McFarlane Gray, objecting to these coefficients, and especially the two last mentioned, on the score of their being "an advance upon perfection," and it was this statement—calling forth, as it did, a reply from Mr. Smith—which was the immediate cause of the correspondence under notice. Originating as a controversy respecting the accuracy of Mr. Smith's coefficients in particular, the discussion has ultimately become one concerning methods of calculating coefficients generally, and it is respecting this latter and more important phase of the argument that we propose to speak here.

* Mr. J. McFarlane Gray, in his letter published in our issue of October 6, mentions that his system of calculating coefficients was described by him in the *Artisan* in 1860, and that he brought this method of comparing engines under the notice of Mr. Elder. Other correspondents affirm that the method of calculating the coefficient by dividing the mean effective by the final pressure, was used by Mr. Elder prior to the date just mentioned; but no evidence has been advanced that Mr. Gray was not the originator of the system of coefficients which he specially claims, and which, as we shall point out hereafter, differs materially in principle from that generally adopted by Mr. Elder.

The subject under discussion is one which admits of division into two parts, the theoretical and the practical, and it appears to us that it may be conveniently dealt with in the form of two questions, namely:—1st. How should the coefficient representing the theoretical efficiency of steam working at any given ratio of expansion be calculated? and 2nd. How can the data necessary for making such a calculation be best obtained in practice from indicator diagrams? These questions we propose to discuss in the order in which we have mentioned them, and in the first place it will be desirable to point out what the difference between the systems of calculating coefficients advocated by Mr. Gray and Mr. Smith really is. In the subjoined figure let $a\,e$ represent the total pressure, and $e\,f$ the volume of a certain given quantity of steam, and let the curved line, $b\,c$, mark the fall in pressure of this steam as it expands from the volume, $e\,f$, to that denoted by $e\,d$. If now we suppose the figure $a\,b\,c\,d\,e$ to be an indicator diagram from an engine in which the steam can be used without being subject to any losses from wiredrawing, compression, back pressure, &c., and without receiving heat from external sources, or losing any beyond that actually transformed into work; then it is evident that the rectangle, $a\,b\,f\,e$, will represent the maximum amount of work which this steam is capable of performing prior to expansion, and the area, $b\,c\,d\,f$, the maximum additional amount of work which is to be obtained by allowing the steam to expand in the ratio $\frac{e\,d}{e\,f}$. In other words the total area, $a\,b\,c\,d\,e$, represents the maximum total amount of work which can be got out of the quantity of steam under consideration, so long as its expansion is limited to the proportion of $e\,d$ to $e\,f$. But the rectangle, $a\,b\,f\,e$, in addition to representing the work done by the steam prior to expanding, may also be taken as representing the quantity of steam used, and if, therefore, this area be used as a divisor, and the area, $a\,b\,c\,d\,e$, as a dividend, the quotient will be a number, or coefficient, representing the work done in proportion to the steam used.



It is this system of calculating coefficients which was originated and is now advocated by, Mr. Gray, and there can be no doubt whatever of its giving a strictly accurate expression of the value of any given degree of expansion. In practice it is not necessary to calculate the areas, $a\,b\,e\,f$, and $a\,b\,c\,d\,e$, and there may be substituted for them respectively the pressure which the quantity of steam, $a\,b\,c\,d$, would possess if expanded in the ratio $\frac{e\,d}{e\,f}$ *without doing work*, and the mean pressure which the steam would have to exert throughout the stroke to develop the amount of work represented by the figure, $a\,b\,c\,d\,e$. To render this more clear, let us suppose the rectangle, $h\,g\,d\,e$, in the diagram to be equal to the rectangle, $a\,b\,f\,e$, then $e\,h$ will represent the pressure of the given quantity of steam if allowed to expand from the volume, $e\,f$, to that denoted by $e\,d$, *without doing work*. Let, also, $e\,k$ ($= p_m$) represent the mean pressure which the steam would have to exert throughout the stroke to develop the amount of work represented by the diagram, $a\,b\,c\,d\,e$, or, in other words, let the area of the rectangle, $k\,l\,d\,e$, equal that of the figure, $a\,b\,c\,d\,e$. It is evident, now, that if we divide the area of the rectangle, $k\,l\,d\,e$, by that of the rectangle, $h\,g\,d\,e$, we shall obtain the same quotient as by dividing the area of the figure, $a\,b\,c\,d\,e$, by that of the rectangle, $a\,b\,f\,e$, while it is further evident that, as the two rectangles, $k\,l\,d\,e$ and $h\,g\,d\,e$, have the same base $e\,d$, we may substitute their vertical heights (or, in other words, the pressures already mentioned) for their areas without affecting the result. Practically it is the pressures just referred to which Mr. Gray employs in calculating his coefficients. The dividend he obtains by measuring the mean effective pressure from the indicator diagrams, the divisor he deduces from a measurement of the diagram at whatever point he considers the latter to show most correctly the quantity of steam which is being used. Of this method of deducing the divisor, however, we shall have to speak when dealing with the second question under consideration, and we merely remark for the present, therefore, that Mr. Gray's object is in all cases to get a divisor corresponding, as exactly as possible, with the pressure represented by $e\,h$ in the theoretical diagram we have been considering.

We must now speak of the system of calculating coefficients advocated by Mr. Smith, and we may say at once that, regarded strictly, it is a false one. Of its practical advantages and defects we shall speak hereafter. The method of calculation which Mr. Smith upholds as theoretically accurate—and which we must ourselves own as having commended as convenient—is that of obtaining the coefficient by dividing the mean effective pressure by the terminal pressure, or—referring to the diagram—by dividing $e\,k$ by $e\,d$. Now if is evident that this is equivalent to dividing the area of the rectangle, $k\,l\,d\,e$, by that of the rectangle, $i\,e\,d\,e$, and thus we see that the difference between the two systems of calculation simply is that, while the dividend is the same in the two cases, Mr. Gray uses as a divisor *a quantity representing the amount of steam used per stroke to perform the work*, while Mr. Smith employs *a quantity representing the steam thrown away after the work has been performed*. It is evident that, under these circumstances, the coefficients obtained by what we shall term, for convenience, Mr. Smith's system, must always be greater than those obtained by Mr. Gray's, the difference depending upon the quantity of heat actually transformed into work during the expansion of the steam.

We have said that Mr. Smith's system is theoretically false, and even at the risk of explaining some self-evident facts, it may be desirable that, before proceeding further, we should prove that this is so. To do this, let us again refer to the diagram, and consider what can be done with the quantity of steam represented by the rectangle $a\,b\,f\,e$. If we suppose this initial quantity of steam to be a constant, and further imagine the expansion to be allowed to proceed to an extent beyond that shown in the diagram, then any increase in the area of the figure representing work done (due to that increase of expansion), will, according to Mr. Gray's system, represent an exactly equivalent increase in the coefficient. This, it is evident, is as it should be. But, on the other hand, if the final pressure be used as a divisor, this divisor becomes reduced by the further amount of expansion which we have just supposed to take place, and thus the resulting coefficient is increased not merely by the work done being greater, but by the divisor being made less. In other words, the quantity of steam used being supposed to remain constant, the coefficient, if calculated according to Mr. Smith's rule, increases as the amount of expansion increases in a more rapid ratio than the work performed; a result which evidently renders a coefficient so calculated a false measure of the efficiency of the steam.

We have now to consider more closely the amount of the difference between the two systems of calculating coefficients, and the limits of that difference. In doing this we shall have to refer to the invaluable researches of Professor Rankine, and here we shall for convenience follow Mr. Smith's example, and adopt Professor Rankine's notation. The few symbols which we shall employ have the following values: p_2 = absolute pressure of the steam during the admission; p_4 = absolute pressure at end of the expansion; p_m = mean absolute pressure during stroke; v_1 = volume of steam admitted; v_4 = volume

of steam at end of expansion; r = ratio of expansion, $= \frac{v_2}{v_1}$; and i = an index which differs with circumstances, and which represents the power of v, according to which p varies. These matters premised, we may now proceed with our investigation. Referring again to the diagram, it will be evident that the difference between coefficients calculated in the two methods will depend upon the difference of the pressures* $g\,d$ and $c\,d$, or, in other words, upon the nature of the curve $b\,c$ representing the variation of pressure as the steam expands. If that expansion takes place according to Mariotte's law, the steam doing no work, then the curve $b\,c$ would be a common hyperbola, and $c\,d$ would be equal to $g\,d$, or the coefficients calculated by the two systems would be identical. But when steam performs work during its expansion, the pressure falls in a more rapid ratio than the volume increases, and the curve $b\,c$ becomes, approximately, one of a hyperbolic class falling within the common hyperbola, which latter is supposed to be represented on the diagram by the dotted line $b\,g$. If the expansion curve was a common hyperbola, the whole area $a\,b\,c\,d\,e$ would be to the area of the rectangle $a\,b\,f\,e$ as 1 + hyp. log. r : 1, or, in other words, if the rectangle $a\,b\,f\,e$ be taken as the unit of measurement, the area of the whole figure $a\,b\,c\,d\,e$ (and consequently the coefficient, under these circumstances, would be represented by 1 + hyp. log. r). If, however, the pressure does not vary directly as v, but as some particular power of v represented by $-i$, then, according to Professor Rankine's integration,† there is to be substituted for hyp. log. r, the quantity $\frac{p_1 v_1 - p_2 v_2}{i-1}$. Let us call this quantity H, and let us make p_1 and v_1 each equal 1 (that is express p_2 and v_2 in terms of p_1 and v_1 respectively), then we have $v_2 = r$ and:

$$H = \frac{1 - p_2 r}{i - 1}.$$

But, according to Professor Rankine, in the case of steam expanding against pressure (or, in other words, doing work) without receiving heat from, or imparting heat to, surrounding objects, the pressure varies approximately as the reciprocal of the tenth power of the ninth root of the volume, or, expressed in symbols,

$$p \propto v^{-\frac{10}{9}}.$$

Thus, in this case, $i = \frac{10}{9}$; $i - 1 = \frac{1}{9}$; and $p_2 = r^{-\frac{10}{9}} = \frac{1}{r^{\frac{10}{9}}} = \frac{1}{r \times r^{\frac{1}{9}}}$. Substituting these values in the equation for H, given above, we get:

$$H = \frac{1 - (r \times \frac{1}{r \times r^{\frac{1}{9}}})}{\frac{1}{9}} = 9 - \frac{9}{r^{\frac{1}{9}}},$$

which corresponds with Mr. Gray's rule, given by him in his letter published by us in our number of November 3rd. In that letter Mr. Gray said: "The coefficient for the work done by expansion alone, when that is accomplished with non-transmission of heat, is found thus: Rule. Divide nine by the ninth root of the ratio of volumes, and deduct the quotient from nine." This rule is, as we have just shown, a strictly accurate deduction from Professor Rankine's integration. It must be borne in mind that the quantity given by this rule expresses the area of the space, $b\,c\,d\,f$, in terms of the rectangle, $a\,b\,f\,e$. To obtain the whole area of the figure, $a\,b\,c\,d\,e$, expressed in terms of the rectangle, $a\,b\,f\,e$, or, in other words, to get Mr. Gray's coefficient, it is, as Mr. Gray stated in his letter, only necessary to add 1 to the quantity given by the above rule. Thus the formula for Mr. Gray's coefficient, which latter we will call G, becomes:

$$G = 10 + \frac{9}{r^{\frac{1}{9}}}.$$

But we have already shown that Mr. Gray's coefficient is also obtained by dividing $e\,k$ by $g\,d$, and, as $e\,k = p_m$ and $g\,d = \frac{p_1}{r}$, we also get the equation:

$$G = \frac{p_m\, r}{p_1}.$$

We must now turn to Mr. Smith's coefficient, which, for convenience, we will call S. This coefficient is given by the equation:

$$S = \frac{p_m}{p_2};$$

but $p_2 = p_1 r^{-\frac{10}{9}}$, and therefore:

$$S = \frac{p_m}{p_1 r^{-\frac{10}{9}}} = \frac{p_m\, r^{\frac{10}{9}}}{p_1};$$

or, in other words:

$$S = G \times \frac{r^{\frac{10}{9}}}{r} = G \times \frac{r \times r^{\frac{1}{9}}}{r} = G\, r^{\frac{1}{9}}.$$

From this, and the first equation for G, we get:

$$S = r^{\frac{1}{9}} \left(10 - \frac{9}{r^{\frac{1}{9}}}\right) = 10 r^{\frac{1}{9}} - 9,$$

which last is the equation given by Mr. Smith in his last letter but one.

The result of this investigation shows that Mr. Smith's coefficient is equal to Mr. Gray's, multiplied by the ninth root of the ratio of expansion, and from this we deduce that the theoretical error involved in employing Mr. Smith's coefficient, increases with the expansion in the proportion of that ninth root. The effect of this error with large measures of expansion is very noteworthy. A mere inspection of the equation for G will show that, in a certain degree, as the ratio of expansion increases, so the second quantity, $-\frac{9}{r^{\frac{1}{9}}}$, will diminish, and the coefficients will approach more and more nearly to 10. With an infinite ratio of expansion the coefficients would be an infinitely small quantity less than 10, and, in fact, 10 may be termed the limiting value of Mr. Gray's coefficient. With Mr. Smith's coefficient, however, it is far otherwise. An inspection of the equation $S = 10 r^{\frac{1}{9}} - 9$ at once shows that, as r increases towards infinity, so the coefficient will also increase (almost exactly as $r^{\frac{1}{9}}$ in the case of extremely high degrees of expansion) towards infinity, a state of affairs quite incompatible with the known laws governing the transformation of heat into work

It will be seen from what we have just stated that Mr. Gray is perfectly justified in asserting that when he obtains a coefficient of, say, 2, by his method, that coefficient means that there has been got out of the steam $\frac{2}{10}$ of the total amount of work which it is theoretically capable of developing. If the coefficient is 3, then $\frac{3}{10}$ of this maximum amount of work has been obtained, and so on.* It is the fact of Mr. Gray's coefficient constituting an absolute measure of this kind which gives it its special value.

In order to point out clearly the extent of the difference between Mr. Gray's and Mr. Smith's coefficients for the different degrees of expansion usually met with in practice,† we give in the next column a comparative Table, in which the two sets of coefficients are given side by side, for values of r varying from 1.5 to 12. For further comparison we have also added a column giving the maximum coefficients obtainable if the steam expanded according to Mariotte's law, that is, if it expanded without doing work, or if, during expansion, it received from external sources an amount of heat exactly corresponding to the work developed.

It must be remembered that the coefficients given in the annexed Table are the maximum theoretical coefficients, and that they are perfectly unattainable in practice. Of the various causes which in practice tend to reduce the coefficients we shall at present only consider the back pressure for the purpose of showing its effect. We have seen that in obtaining the coefficient the mean effective pressure may be considered as the dividend, and thus, in whatever proportion this dividend is reduced, so will the coefficient be reduced also. Thus, if the back pressure amounts to one-tenth of the mean effective pressure which would have been available if no back pressure existed, then this back pressure will reduce the coefficient one-tenth, and so on. To express this in the form of an equation, let the back pressure be represented by p_3, and the maximum coefficient obtainable practically with that amount of back pressure (supposing no other sources of loss to exist) to be represented by G_1; then:

$$G_1 = \frac{G \times (p_m - p_3)}{p_m}.$$

We have now reviewed the question of coefficients from its theoretical aspects, and have, we trust, shown clearly that Mr. Gray's system is the only one which gives a really theoretically accurate measure of the efficiency of the steam used; and we believe that all those of our readers who have studied the question carefully, and even those who may at present be opposed to Mr. Gray, will ultimately feel indebted to him for the trouble he has taken in explaining his system and maintaining its accuracy. The length to which the article has already extended prevents our dealing here with the question, as to how the data for calculating coefficients can be best obtained in practice from indicator diagrams. This question we shall probably deal with next week, and meantime we need merely remark that Mr. Smith's system, as carried out in practice, is frequently far more nearly correct than when regarded in its abstract form.

Ratio of expansion = r.	Maximum theoretical coefficient by formula $C = 10 - \frac{9}{r^{\frac{1}{9}}}$. [Mr. Gray's.]	Maximum theoretical coefficient by formula $C = 10 r^{\frac{1}{9}} - 9$ [Mr. Smith's.]	Maximum theoretical coefficients, supposing that the expansion took place according to Mariotte's law = $C = 1 + \text{hyp. log. } r$.
1.5	1.396	1.46	1.405
2	1.666	1.80	1.693
2.5	1.870	2.07	1.916
3	2.034	2.30	2.099
4	2.283	2.67	2.386
5	2.473	2.96	2.609
6	2.624	3.20	2.792
7	2.750	3.42	2.946
8	2.857	3.60	3.079
9	2.949	3.77	3.197
10	3.031	3.88	3.303
11	3.104	4.05	3.398
12	3.171	4.18	3.485

THE 35-TON GUN.

The 35-ton gun has advanced another stage in its career at Woolwich, and has involved itself and the Committee on Explosives in fresh difficulties, more serious than those which have gone before. The fact is, the gun is now cracked, the injury having occurred in the steel lining-tube. The experiments which we recorded last week, were to have been the last to which the weapon was to be subjected, before its removal to Shoeburyness for practice against the targets. For some reason or other, it was decided to fire a few more shots before sending it away, and several rounds were fired with 120 lb. of powder, and the usual 700 lb. flat-headed proof projectile. An examination of the pressure-gauges after firing, showed that in one instance, the enormous strain of 66 tons per square inch had been brought upon the gun, being almost double the ordinary average pressure. Gutta-percha impressions of the bore were then taken, and they disclosed the fact, that there was an incipient crack in the steel lining-tube, extending for a length of 4 in. along one of the grooves. Of course, the specific remedy would be to retube the gun, but as it is considered to be of more importance to ascertain how far these guns may be depended upon under similar conditions in practice, it has been decided to test its endurance still further, and the casualty will thus be converted into a valuable experience. The gun will now be lifted from the iron service carriage on which it at present rests, and be re-mounted on its former timber sleigh. It is therefore probable that it will be tested to destruction, and may never reach Shoeburyness at all. It will, however, be satisfactory to know to what limit the power of endurance

* It will be remembered that $g\,d$ is the height of a rectangle $h\,g\,d\,o$, equal in area to the rectangle $a\,b\,f\,e$.

† *Vide* page 380 of *The Steam Engine and other Prime Movers*. Third Edition.

* In making this statement it is, of course, assumed that the pressure of the steam will continue to vary as $r^{-\frac{10}{9}}$. This is not absolutely correct when extreme measures of expansion have to be dealt with; but the error involved in the assumption is inappreciable with all degrees of expansion employed, or likely to be employed, in practice.

† For convenience in working out these coefficients and some of the formulæ already given, we append here a Table of the $\frac{1}{9}$ and $\frac{10}{9}$ powers corresponding to different values of r, which our readers may perhaps find useful.

r	$r^{\frac{1}{9}}$	$r^{\frac{10}{9}}$
1.5	1.046	1.569
2.0	1.080	2.160
2.5	1.107	2.768
3.0	1.130	3.390
4.0	1.167	4.666
5.0	1.196	5.979
6.0	1.220	7.322
7.0	1.242	8.690
8.0	1.260	10.080
9.0	1.277	11.493
10.0	1.288	12.885
11.0	1.305	14.360
12.0	1.318	15.816

of these weapons really extends, in order that there may be no want of confidence in them in use. With regard to the cause of the crack, we do not consider it to have been occasioned by the one solitary round which registered 66 tons pressure, but to have been developed in the course of the practice. We may here remark that the daily press has almost without exception taken pains to point out that the casualty arose from the fact that the registered pressure on the tube (66 tons) at the last explosion, exceeded by 16 tons the ultimate tensile strength (50 tons per square inch) of the steel composing the tube; it is scarcely necessary to remark that this 50 tons of itself is no measure of the strength of the gun. We are now, less than ever, inclined to attribute the wide ranges of pressure to the powder, which is of a uniform character; but, as we stated last week, to a defect in the apparatus used in ascertaining them. That defect may arise from a want of perfect uniformity in the metal, from which the pellets are made, or from the imperfect action of the striker. We cannot, upon any other grounds, account for the fact of two 120 lb. charges of the same powder registering—as they have lately done—the one a pressure of 21.6 tons, and the other a pressure of 66 tons per square inch.

EGYPTIAN RAILWAYS.

A FRENCH engineer, writing lately upon Egyptian railways, says that it is easy to predict, with certainty, that with the existing system—that is to say with an administration careless, idle, and incompetent, with a staff having only one object, that of plunder and dilapidation, the management will scarcely be able to make receipts balance working expenses. This is a hard prophecy, but it is based upon experience, and would probably be justified by events had not the Khedive lately shown a determination for reforms that have now

TABLE OF MILEAGE OPEN IN 1870.

		Miles. chs.	Miles. chs.
Alexandria to Cairo (double line)	...		131 00
Benha to Suez (single line)		122 44	
Tantah to Talkha	„ „	33 00	
Tantah to Chibin-el-Kaum	„ „	16 60	
Mehallet Rorh to Zifta	„ „	23 52	
„ „ to Dezouk	„ „	36 38	
Calioub to Barrage	„ „	7 40	
Mitbere branch	„ „	8 00	
Calioub to Mansourah	„ „	88 71	
Neficho to Ismailia	„ „	2 32	341 24
Total mileage in Lower Egypt	...	...	472 24
Embabeh to Minieh (single line)	...	151 11	
Wasta to Fayoum	„ „	... 25 00	
Abd-el-Ouakf branch	„ „	... 4 00	
Total mileage in Upper Egypt	...	...	180 11
Total		..	652 35

The following Table gives the distances between principal stations:

Names.	Distance.
Alexandria and Cairo	131 miles
„ „ Suez	224¼ „
„ „ Talkha	109¼ „
„ „ Zigazig	125¼ „
„ „ Zifta	110¼ „
„ „ Dezouk	123 „
„ „ Mansourah	172¼ „
Cairo and Suez	150¼ „
„ Zigazig	52 „
„ Mansourah	172¼ „
„ Zifta...	88¼ „
„ Minieh	151¼ „
Suez and Zigazig	98¼ „

The receipts upon the Egyptian railways during the years 1867-70 are nearly as follows:

	£
1867-68	1,520,000
1868-69	980,000
1869-70	1,200,000

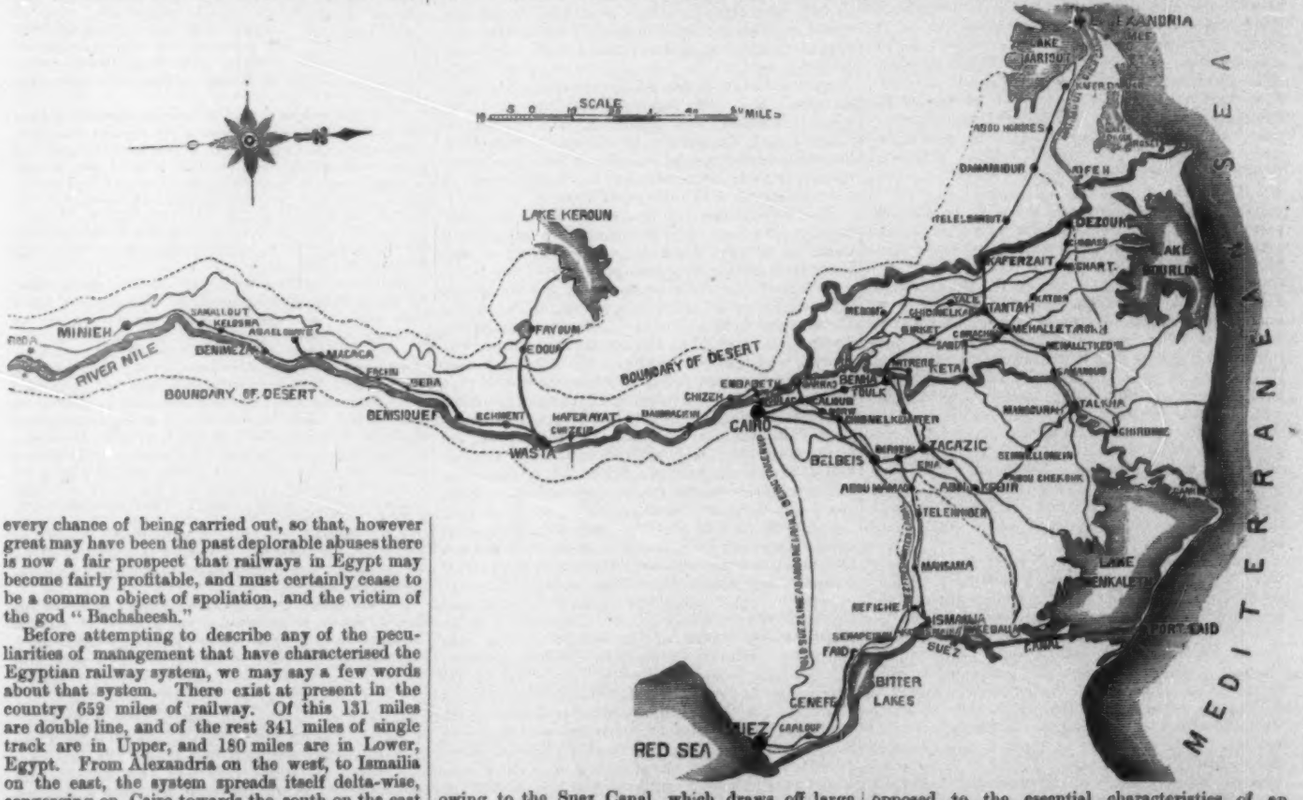
During the present year a further falling off has been experienced. The depreciation is chiefly

Services employing the Egyptian railways.	Amount paid before the opening of the Suez Canal per annum.	Amount paid since per annum.
	£	£
The Messageries Impériales...	72,000	36,000
The French marine ...	80,000	20,000
The French postal service ...	2,880	1,440
The P. and O. Company ...	180,000	84,000
For troop transport ...	160,000	

management, for they can effect of course a considerable saving of time in the transit of the Isthmus, even taking into consideration the delays occasioned by the several transshipments. When a judicious reform in tariffs and administration shall be effected, the railways will doubtless recover a considerable proportion of the through traffic between the Mediterranean and the Red Sea.

We have already quoted the opinion of a French writer, M. A. Nouette Delorme, on the Egyptian railway question. In a pamphlet recently issued by that gentleman on the subject, we find some interesting remarks, which, slightly coloured as they possibly may be, still afford a good insight of the inner workings of Egyptian railway administration.

Oriental nations, as a rule, understand but one interest, that of the individual; but one right, that of force. With them, favour is all, merit nothing, intrigue the sole road to distinction. Apply these principles to railway administration, and the result is seen in the country of the Khedive. The power which confers authority without heed to the antecedents of the favoured one, which elects to responsible posts those who, if qualified for anything, are suited for any position rather than the one they are called upon to occupy, is not likely to be successful in its administration of a system imported from the active nations of Western Europe; one totally



every chance of being carried out, so that, however great may have been the past deplorable abuses there is now a fair prospect that railways in Egypt may become fairly profitable, and must certainly cease to be a common object of spoliation, and the victim of the god "Bachaheesh."

Before attempting to describe any of the peculiarities of management that have characterised the Egyptian railway system, we may say a few words about that system. There exist at present in the country 652 miles of railway. Of this 131 miles are double line, and of the rest 341 miles of single track are in Upper, and 180 miles are in Lower, Egypt. From Alexandria on the west, to Ismailia on the east, the system spreads itself delta-wise, converging on Cairo towards the south on the east bank of the Nile, while on the opposite side of the river from Embabeh to Minieh the line follows the river bank with two short branches—one to Fayoum, 25 miles long, and a second to Abd-el-Ouakf, 4 miles in length. The double line is the through railway from Alexandria to Cairo.

The accompanying map will serve to show the direction and extent of the existing system, and the following Tables contain the statistics of lengths and distance:

owing to the Suez Canal, which draws off large sources of revenue, to the great loss of the railways, but it is affirmed to the comfort of the officials, who are relieved of much distasteful trouble and labour. The approximate figures in the adjacent Table will serve to show how much the lines have suffered by the opening of the canal.

And this reduction will doubtless become more striking as the canal traffic is constantly increasing. That the loss to the railways is so great must, however, be partially attributed to the unfortunate opposed to the essential characteristics of an Eastern race. Such a system was certain to be travestied by native officials, and abused by foreign fortune seekers, particularly when absolute power could instantly compel the resignation, or caprice and intrigue compass the degradation of a man, who, possibly capable, might have striven to amend abuses and bring some order out of chaos. Moreover, the regulation by which each two years the directors of railway matters are replaced by a new administration, has increased the existing evils, the

work of the retiring directors has been undone by their successors, who in turn give place to new management.

Probably one of the most active administrators was Ali Pacha-Moubarek, who applied himself earnestly to the reform of the most glaring evils. Unfortunately, however, being at the head of several other departments, he could only devote a portion of his time to the work; but, despite all the hindrances he met with on the part of those who saw their privileges and advantages disappearing, he did much. Thus he supplied many deficiencies in material and construction, he established something like order in the great stores of Boulak, where previously had reigned unimaginable confusion, where field instruments, boiler fittings, and old iron, heavy and light goods, paper, machinery, oil, general stores, and fabrics were all mingled together pell-mell. Besides this, he caused to be repaired some forty-five engines which had been left on sidings unprotected, ranked as useless, and stored the new locomotives which had been ordered from England to replace them. He reorganised the various offices, and imported something like order into them, to the disgust of employés, who sighed for his resignation. Trains left more punctually, passengers could obtain information, could purchase tickets, and quit their baggage with some hope of meeting it again. But, unfortunately, Ali Pacha-Moubarek quitted office, and but little good and much harm was done afterwards, and affairs flowed again rapidly towards their wonted channel.

(To be continued.)

FRENCH RAILWAYS.

We have exhausted the list of the disasters sustained during the late unhappy Continental conflict by the Western of France Railway. The experiences of another great French company—the Orleans—in the autumn and winter of last year and the spring of 1871 are also not without interest. When the war between France and Germany broke out, all the company's means of action were employed in the concentration of troops on the Rhine frontiers. After the disasters of Weissemburg and Reischoffen, and, finally, after the capitulation of Sedan, the company's plant had to be applied to another purpose, viz., the supplying Paris with provisions, since a siege of the capital became imminent. While the goods trucks of the undertaking conveyed to Paris an immense quantity of flour, food products, and munitions and matériel of war, the passenger carriages were used for a prodigious emigration from Paris to the departments, large numbers of families being invited to leave Paris for a time. The company's termini on the Boulevard de l'Hôpital and Montrouge were carried almost by assault by numbers of travelling families carrying with them their beds, their furniture, and such masses of baggage that it was necessary to suspend its delivery in order to maintain regularity in the train service. These three immense movements were effected between the commencement of the war and the siege of Paris with a remarkable degree of precision, notwithstanding great difficulties which had to be overcome. They were almost completely terminated when the investment of the capital intercepted all further communication with it. The extraordinary state of affairs commenced September 17, 1870.

The directors had adopted while the Germans were advancing on Paris such measures as they deemed most advisable for the continuance of the company's business and the protection of its interests. The central traffic service was removed to Tours September 19, and a delegation of the Council of Administration also proceeded to that town. The other part of the council remained at Paris with the managing director in order to watch over the affairs of the company in the beleaguered capital. With the siege of Paris a new phase of the company's history may be said to have commenced, because nearly all its means of transport were devoted to the service of the national defence. The receipts do not enable any conclusions to be drawn as to the activity which prevailed—although in an altered form—upon the company's lines as the movement of troops and matériel of war had to be effected at special reduced rates. In the last six months of 1870 the military traffic of the company comprised 1,500,000 men, 150,000 horses, and 120,000 tons of munitions and stores. Of course some soldiers and regiments were carried more than once over the company's lines or some of them during the period in question; otherwise, the vast aggregate mentioned would never have been attained. The great movements of men and stores which took place in the autumn of 1870 were frequently hasty, and always tumultuous, while they were often ordered by the Minister of War without any preliminary notice being given. They compelled the directors to keep a portion of the rolling stock idle, and to hurriedly suppress general traffic upon some sections. The lines of the company, and especially junction stations, were also blocked up with trucks laden with supplies for the army; at Tours, for instance, there were sometimes as many as 1200 trucks set fast in this manner.

In the midst of ever-increasing difficulties the company was obliged to follow the retreating movements of the French army, and to successively abandon the working of the lines from Paris to Orleans and Châteaudun, from Châteaudun to Vendôme, from Orleans to Vierzon and Blois, from Tours to Blois, Vendôme, Le Mans, Vierzon, Saumur, and finally Châtellerault. In January of this year the length of the line remaining in working was reduced to 550 miles, and the delegation of the directors, which had established itself at Tours, was obliged to remove to Bordeaux, and to direct operations from the latter city. While all this was going on the directors of the company remaining in Paris did not remain inactive, but they contributed to the utmost of their power to the defence of the capital. Two ambulances, comprising one 80 beds, and the other 20 beds, were installed in the Ivry workshops, and in one of the large rooms of the company. The workshops of the undertaking coming to the aid of the State repaired arms, manufactured cannon, armour-plated batteries, &c. Two mills, fitted up in the Paris and Ivry stations, worked 30 pairs of stones, and ground 27,334 quintals of grain for the production of bread during the last few weeks of the siege. The steam pumps were used in supplying the besieged with water; 25,000 sheep were kept for two months in the Ivry goods warehouse; the company's horses were employed every day in distributing food upon the ramparts and in the city, in the removal of the wounded, in the service of the artillery, the commissariat, &c. The principal terminus at Paris, where the arrival and departure of trains was no longer heard, was transformed into a vast workshop for the manufacture of balloons which bore away the hardy messengers who put the besieged city in correspondence with the rest of France.

The preliminaries of peace, far from relieving the company from its difficulties only aggravated them for a time. Thus the directors had to save Paris from famine by a prompt supply of provisions and to work the lines occupied by the Prussians. The supplies collected in November, 1870, by the Government of the National Defence, and in the Lower Loire formed at the commencement of February a load for no less than 7000 trucks, without taking into account the great demand for transport on the part of the commercial world generally; but as the Prussians occupied and worked the company's lines as far as Tours and the Ferté, the traffic could only be conducted with their consent and at their convenience. When the revictualling of Paris by the company's system commenced February the 3rd, the Germans only permitted four trains to be worked daily in each direction. The number was extended to eleven from February the 6th, and the mixed working of the lines was carried on upon these deplorable conditions until the 13th of March. It would have been prolonged still further if the company had not made exertions to facilitate the return of the hostile troops into Germany. In order to regain its freedom of action, the company engaged to sustain its share in the lending by the French Government of 5000 carriages and trucks to the German authorities, as well for the removal of their army as for the repatriation of the French prisoners. If this convention had been faithfully executed, the number of 5000 trucks would not have been exceeded, and they would not have remained absent more than three weeks. As a matter of fact, however, from 10,000 to 12,000 carriages and trucks actually left France for Germany in the course of March, 1871, and the majority of them were detained in Germany for months. In recently defending the administrations of the French railway companies from the not unjust complaints of the French commercial world in regard to the present scanty supply of rolling stock upon the French systems, the French Minister of Public Works computed the number of railway trucks and vehicles damaged or borrowed by the Germans at about 30,000. Notwithstanding all these embarrassments peace began to communicate some regularity to French commerce, and in consequence to the traffic of the company when the Parisian insurrection broke out, and once more checked the comparative amelioration in affairs. But time has brought with it its usual healing influence, and probably no useful purpose will be served by pursuing further the gloomy topics of which we have been treating.

THE MILAN EXHIBITION.

The competitive examination of the industrial efforts of Italy has just passed through another successful course, at the National Exhibition of Arts and Manufactures held in Milan—an exhibition carried out solely by the efforts and desires of its promoters—private citizens of the old and famous city, and whose present wish has been to revive, not only a national and a local industry and skill, but to stimulate the advancement of Arts, Manufactures, and Industry.

The Exhibition buildings are erected in a picturesque angle of the public garden, with nothing of outer grandeur of effect in architectural design; but the internal decorations have been executed with true artistic taste and skill; more especially those of the Hall, rendered more striking by the quantity, beauty, and richness of its colouring, and the objects there exhibited. The annexes present the usual display on a small scale, of machinery, &c. The great merit of the Exhibition is noteworthy, as having been proposed and carried to its successful issue, by the energetic efforts of Professor Luigi Luzzati, who is Deputy-Member of Agriculture and Commerce, and who possesses that passionate love of art and his country, combined with a modern intelligence, that gives life and movement to a crowd of popular and economic institutions of learning and art in Milan. Encouraging all classes of people, he has induced them to form amongst themselves co-operative societies, to advance their household and social comforts, and has established on a safe basis the principles of labour, as between the employer and the employed; he has founded people's banks; has induced the small retailers, who deal with the earnings of the artisan, to unite their efforts to establish a system of fairness in all their dealings with the working classes; and persuaded the rich patricians to perform many good and noble works for the benefit of these classes—the progress of industry and the protection of the workmen.

Three rich, powerful, and prosperous associations have thus been founded in Milan with every prospect of success. The Co-operative Society of the Printers, which, above all the other associations of their kind, is based upon a most just and equitable foundation, between capital and labour, and is progressing most successfully and vigorously—the People's Bank, and, finally, the Industrial Exhibition; this last will give a considerable impetus to the progress and improvement in the industrial branches of Milan and its surrounding influences.

The present building is built on the site, where stood the studio of the sculptor Marchese. The public of Milan ubscribed half the amount for the construction of the necessary buildings, viz., 33,000 liras or 1375*l*., the Government of Italy granting a concession of 10,000 liras. The province of Milan, 5000 liras, and the municipality of Milan 10,000 liras, amounting to pounds sterling, 2416*l*., which, with the admission fees, amounted to a total of nearly 4000*l*., which not only covered all the expenses, but finally left with a surplus of 30,000 liras, which the Industrial Association have reserved for themselves to invest as a fund for future operations of a similar kind, this being the first and only Italian exhibition that has shown a balance on the credit side of the account! The first exhibition at Firenzi cost a million of liras, and closed with a debt, as also the Maritime Exhibition, held in Naples, which cost more than a million of liras, and closed with many liabilities left unadjusted though it received large and liberal donations from its Government.

The Committee at Milan have resolved to follow the English system of encouraging the progress of art and manufactures by bringing together into competition, yearly, the results of all classes of Italian industries, until they shall have gained sufficient strength to enter into competition with the richer and more mature developments of London, Paris, or Vienna, and other cities, when the porcelain of Firenzi, the manufactures of Turin, the arms of Brescia, and the various instruments of Bologna will be thrown boldly into public competition. There is every hope that in the future, Italy may enter the lists with any other city in Europe, from the very satisfactory and successful results of the Exhibition just closed, which give us hope that the citizens of Milan, may be further encouraged, and that they may learn that not pretension, or favour, or laws, but solely and exclusively the individual will and desire of its people to achieve success, will advance the prosperity of the nation.

The West India and Panama Cable.—Information has been received by the India-rubber, Gutta-percha, and Telegraph Works Company, of the completion of the Jamaica to Porto Rico section of the submarine cable laid for the West India and Panama Company.

RAILWAY PROJECTS FOR 1872.

JUDGED by the number of plans deposited at the Private Bill Office of the House of Commons on the 30th of last month, the Session 1872 promises to be a heavy one. According to the official list the members will have to adjudicate upon 270 Bills of one kind or other, with which plans are connected, although this number will of course be somewhat reduced before the list is cleared by the Examiners on Standing Orders. As there are several competing schemes we may look for some sharp fighting on Committee especially on tramway questions, and the crossing of the river Severn, for effecting which object there are four bridge schemes and one tunnel proposed. The deposits at the Board of Trade number two hundred, but as these are all duplicates of others deposited at the Private Bill Office, we shall confine our remarks to the latter plans. An analysis of these shows that in the approaching Session the Government will have to deal with 144 railway schemes, 28 tramway bills, 53 bills of the miscellaneous class, including docks, harbours, local improvements, gas, water, and irrigation works. Besides these there are 44 sets of plans deposited with applications for provisional orders or certificates in accordance with Standing Order No. 227, and relating to works of all the above classes. These give a total of 269 sets of plans regularly deposited, the 270th being the Blyth and Tyne Railway, which found its way into the Private Bill Office on the 1st instant. These deposits show an advance of 43 upon those made in November, 1870, which comprised 85 railways as against 144 in the present year; 18 tramways as against 28; 77 miscellaneous as against 53; 45 provisional orders as against 44, and 2 Bills deposited on the 2nd of December, making the total of 227 for the past Session as against 270 for the one to come. The increased number of railway Bills is at least an answer to those who believe there is no more work to be done in that respect at home, the applications for releases and deviations notwithstanding. We hold that there is plenty of room for railways yet, provided they are economically constructed, and the fact that engineers are recognising this necessity is to be found in the circumstance that several of the deposits are for narrow gauge lines, that is as contradistinguished from the conventional 4 ft. 8½ in. gauge.

Glancing first at those railway schemes which propose to affect the metropolis and the suburban districts, we find a proposition to connect the Great Eastern, the North London, and the East London Railways with the Metropolitan and Metropolitan District Railways. To effect this object three lines of railways are to be constructed. The first is to start from the authorised Tower-hill extension of the Metropolitan Railway and to join the North-London Railway at the Bow-road. The second is to leave the Metropolitan District Railway near Old Fish-street, and is to join the first line under Whitechapel High-street. The third line is intended to complete the North-Eastern and North-Western portion of the inner circle of the Metropolitan Railway system. It is to leave line No. 1 in the Whitechapel-road and to join the Metropolitan Railway near Moorgate-street. The London and South-Western Railway Company are proposing to effect a junction between their line and that of the London, Chatham, and Dover Company by means of a railway from their Waterloo Station to the Blackfriars Station of the latter company. The Metropolitan District Company propose an extension of their line to that of the South-Western Company at Barnes. The railway is to commence by a junction with the West Brompton line near the Warwick-road, and will pass by a bridge over the Thames through Wandsworth and Putney to the Barnes up-station of the South-Western Company. It is intended to utilise the railway bridge as a foot bridge for passengers, tolls being levied of course. Another scheme in the same direction is proposed under the title of the Metropolitan and Wimbledon Railway. The line is to leave the Metropolitan Railway at West Brompton, and is to join the London and South-Western Railway about 400 yards from the Barnes Station. The Wimbledon branch will leave the first line at Dyer's-lane, Putney, and will terminate at the top of High-street, Rochampton.

The Metropolitan and St. John's Wood Railway Company propose three new lines. The first is an extension of the line from its present termination in the Finchley New Road, to the Hampstead Junction Railway near the Edgeware-road. The second line is to start from the same point as the first, and is to join the Midland Railway, where it crosses under the Finchley New Road. The third line it is to leave the Metropolitan and St. John's Wood Railway, near Park-terrace, and to terminate in Green-street, Grosvenor-square. The Mid-London Railway consists of a series of lines starting from the west-end of Oxford-street, and running to the London, Chatham, and Dover Railways near Farringdon-street, and to the East London Railway at St. George's-in-the-East. Junctions are also proposed with the authorised lines of the London Central and of the East London Railways. Two new streets are proposed in connexion with this scheme, the first of which will commence at the corner of Giltspur-street and Newgate-street, and terminate in Moorgate-street, near London Wall, from which point the second street is to be continued to the junction of the Commercial-road and Whitechapel High-street. Another Mid-London scheme consists in the construction of a railway from the London and North-Western Line, at Willesden, to the west-end of Oxford-street. The proposed South Kensington Railway is a line from the South Kensington Station of the Metropolitan Railway Company, to the Albert Hall, at the point where it is connected with the conservatory of the Royal Horticultural Society. By another Bill it is proposed to construct an underground subway and tramway from the South Kensington Station to the courtyard of the Albert Hall. The Fulham Railway is to start from the West London Extension line at its West Brompton Station, and is to terminate in the Burlington-road, Fulham, near Church-street. From this line there is to be a branch, leaving it at the Cedar-road, Fulham-road, and joining the Metropolitan District Railway at the West Brompton Station. The Great Eastern Railway Company propose to connect their line with the North London Railway by a junction from the authorised line of the former company at the Grove-road, Hackney, to the latter company's line at the Greenwood-road, Hackney. We need hardly add that these railways will, for the most part, be underground lines.

The South-Eastern Railway Company propose a short line in connexion with their system at Greenwich. It is to leave their Greenwich line, where it crosses the Deptford Creek, and is to connect it with the railway authorised by their Act of 1871, near King-street, Greenwich, the length of the line being only 1040 yards. By the same Bill they propose a junction line, 560 yards long, between the London, Chatham, and Dover Railway, at Price-street, Blackfriars, and their own Charing-cross line at Great Guildford-street, Southwark. They further propose a station on the North Kent Railway, where the Old London-road crosses it at Northfleet. By the same Bill they seek powers to alter the level of the St. James's-road, Bermondsey, and to divert the main southern outfall sewer at North Pole-lane, Greenwich.

Turning to the provincial plans, the first proposition of magnitude that arrests our attention is the old Brighton, Eastbourne, and London Railway scheme, the title of which it appears to us should have been reversed, inasmuch as it commences by a junction with the London, Chatham, and Dover Railway at Penge, and the South-Eastern Railway at Beckenham. Thence it runs to Brighton and Eastbourne, having branches to Westerham and to the Surrey and Sussex Junction Railway at Oxhead, and a goods branch at Lewes. This scheme involves terms and conditions to be entered into with no less than fifteen companies, so that should the Bill proceed to Committee, there will probably be some work before it gets through. The Great Northern Railway Company, by their Bill No. 1, propose a deviation and a new line at Dewsbury; deviations at other places, and a junction with the North London Railway at the Broad-street Station. The latter line is to commence by a junction with the up lines of the Great Northern Railway at the Seven Sisters'-road, and will join the North London at Highbury-grove. In their Bill No. 2, the Great Northern Company propose the construction of new lines to Erewash Valley, to Derby, and to the North Staffordshire Railway. The Great Western Company have deposited plans for a line from their Swansea branch to the Swansea Vale Railway. It will leave the former line close by the Hafod Copper Works, and will join the latter line near the Tyr Canol Colliery. The Great Western Company also apply for powers, by another Bill, to compensate owners of branch lines in connexion with their system for losses sustained in consequence of the change from the broad to the narrow gauge. The London and North-Western Railway Company are applying for powers for additional works which will include eight branches or junctions. These comprise, firstly, a branch line from the London, Tilbury, and Southend Railway, near its crossing with the North Woolwich Branch of the Great Eastern Railway, to the Victoria Dock. In the next place they propose a loop line starting from their own main line about 2000 ft. from the southern entrance to the Watford tunnel, and passing through Cashio and Leavesden, will rejoin the main line about 1800 ft. from the northern entrance of the Watford tunnel. Another similar loop line is proposed at the Northchurch tunnel and another at the Linslade tunnel. They further propose a junction between their Edgehill and Bootle branch at Edge-lane, and their Liverpool and Manchester line at Newlane, Wavertree. At Liverpool they propose a branch line to be called the Wapping Tunnel Branch, from the Liverpool and Manchester Railway at Upper Frederick-street, to the junction of Crosbie and St. James streets. At Ashton-under-Lyne they propose a junction between their Stockport and Staleybridge line, and the Oldham, Ashton-under-Lyne and Guide Bridge Junction Railway. Finally, they propose a line from their Bettws-y-Coed station, to the Festiniog Railway, which it will join near the High Level Bridge, which carries the Welsh Slate Company's Tramway across it. This branch is to be constructed on a gauge of 1 ft. 11½ in., the same as that of the Festiniog Railway. The Hemel Hempstead and the London and North-Western Company intend to make a short line at Boxmoor. They further propose some deviations in connexion with their Harpenden extension, and certain abandonments consequent thereon.

(To be continued.)

IRRIGATION IN INDIA.—The Duke of Argyll, Secretary of State for India in Council, has sanctioned a further outlay on irrigation works in Orissa. The amount already expended is 117 lakhs, and about 160 lakhs more will be required.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Dividends of Sheffield and Rotherham Iron Works.—A meeting of the directors of Messrs Charles Cammell and Co., (Limited), of the Cyclops Works, Sheffield, was held last week, when it was resolved to pay an interim dividend of 4*l.* per share. The shares are 80*l.* paid up towards 100*l.* The dividend is therefore equal to 5*l.* per cent. The Parkgate Iron Company, Rotherham, near Sheffield, have declared an interim dividend of 3*l.* per share, which was paid on the 1st December

Proposed Corporation Purchase of the Barnsley Gas Works.—An extraordinary meeting of the shareholders in the Barnsley Gas Company was held on Monday, to consider the expediency of selling the works of the company to the Barnsley Corporation. After a somewhat lengthy discussion it was resolved that the works should not be offered for sale to the Corporation.

Extensive Alterations at the Bowling Iron and Steel Company's Works, Bradford.—The management of the Bowling Iron and Steel Company, Bradford, evidently intend to make their producing powers far more capacious than they are at present. The fame of Bowling iron certainly justifies the outlay of capital involved in the very extensive alterations now in progress. In the "Eagle Forge" they have just put down a fine new 7-ton steam hammer made by Messrs. Thwaites and Carbutt, of Bradford. It will be used for heavy forgings. The Eagle Forge itself is also being extended, and it is expected that four additional furnaces will shortly be erected. The old plate mill in the company's works has recently been put into full operation, an enormous demand for boiler plates and tyres being anticipated. In the large plate mill two new engines are to be put down in order to meet the daily increasing demand for large sized plates. The branch of the Great Northern Railway which runs into these works is about to be so extended as to encircle the whole of the works, which will save the present great expense incurred in raising heavy weights to the higher part of the premises. A new furnace for annealing large steel castings is about to be constructed, and it is stated that it will be on a much larger scale than any in the district.

The New Steel Works at Sheffield.—The erection of the new iron and steel works at Attercliffe, Sheffield, for Messrs. George Brown and Company, is being pushed forward with all practicable speed. It is stated that there is some stoppage, possibly only for a time, in the preparations which were lately being made for the construction of new iron works at Heeley, near Sheffield.

Extension of Works at Leeds.—The Aireside Iron Company at Hunslet, near Leeds, are erecting a large furnace—the second recently put up. Messrs. Kitson and Co., of the Airedale Foundry, are making for the first-named company a direct acting blowing engine, with a 100-inch cylinder. It will be used for blowing both the company's furnaces. It is rumoured that new works of some magnitude for the manufacture of Bessemer steel are about to be erected at or near Leeds; but the rumour requires confirmation.

The Affairs of Messrs. W. Charles and Co., of Sheffield.—It is stated, on the best authority, that several Sheffield firms are heavily involved in the failure of Messrs. Charles and Co., and it is stated that two of them have already suspended payment. This rumour, although it may be correct, requires further confirmation before it is generally accepted. It was stated at the meeting of Messrs. Charles and Co.'s creditors, that accommodation paper to the extent of about 80,000*l.* was in circulation out of a total liability of 218,000*l.* The acceptances of the firm are 98,000*l.*; bills receivable 116,000*l.*; of which 16,000*l.* represent goods sold, and the balance is accommodation paper, which has yielded 50,000*l.* in cash, 20,000*l.* is owing on open accounts and money borrowed. As assets, the Millsands and Spring Works are, valued at 100,000*l.* To be deducted from this amount are two mortgages; total, 30 000*l.*, and the bank holds a covering mortgage of 50,000*l.* to meet bills, which, if not met, it will have to claim. The balance of these items leaves 20,000*l.* towards general assets, and a further sum of 70,000*l.* is expected to be realised from stock-in-trade and book debts, making a total of 90,000*l.* 30,000*l.* should be deducted from the 218,000*l.*, being part liabilities on acceptances, for which the bank holds security, and which is included in the 50,000*l.* These figures are of course but approximate. A general meeting of creditors will be held in Christmas week.

Leeds Water Works.—A tunnel about 670 yards in length is about to be driven by the Leeds Corporation Water Works at the Swinsty reservoir works, which are situate in the valley of the river Washburne. A surface condenser is also to be applied to one of the engines at the Headingley pumping station.

ENGINEERING IN EGYPT.—The staff of engineers sent out by Mr. Fowler, on behalf of the Government of Egypt, to survey and lay out the proposed Soudan Railway, have already commenced operations on the whole length of the line between the second Cataract and Khartoom. The staff, which consists of twenty experienced English surveyors, an English surgeon, and numerous native assistants, are all in excellent health, and speak highly of the arrangements of the Egyptian Government in carrying out Mr. Fowler's programme for their progress and work. The highest importance has long been attached to this railway communication in the interests of Egypt. The vast area of rich land above the sixth Cataract is capable of producing sugar, cotton, grain, &c., to an extent almost unlimited, but the present means of transport are dependent on the employment of camels for several hundred miles, and all exportation, therefore, except of spices and similar products, is simply impossible. It is not improbable that more frequent intelligence from Sir Samuel Baker may be obtained from the facilities afforded by this expedition.—*Times.*

NOTES FROM PARIS.

PARIS, Dec. 2, 1871.

A New Society.

In 1870 there was formed in Paris a new society, bearing the title of the Syndicate of Commerce and Industry in affairs of Transport, having for its object to replace—in the relations between merchants and manufacturers, and railway companies—weakness of isolated action, by the power of union and permanent coalition.

The French railways are worked by a small number of powerful companies, enjoying and abusing the monopoly that has been intrusted to them, and imposing conditions on the public which are detrimental to commercial interests. But the companies have so great an importance; their relation with the State, and the successive modifications made in their financial arrangements, have become so advantageous, that they are able to carry all before them, and maintain undisputed the greatest abuses. The original rates of charges, established at the commencement of the creation of railways, when the only available means of estimating expenses, were the costs of transport on common roads, and in this way very high maximum tariffs were conceded to the companies.

It is true that in general the railways do not apply these maximum rates, but commerce complains, first, that the rates have not been lowered to those limits which are fairly possible, and are absolutely required by the necessities of business; they have only been so reduced upon certain lines, where the competition of river or canal transit enforced it on the companies.

The railways were privileged also to make very great delays in the transport of goods, and these delays have not been properly reduced. Special tariffs in infinite number are charged by the companies for the transport of special merchandise, for despatching them to special stations, or for the transit across France of foreign goods. These tariffs are variable, and the facility of brusquely changing the conditions of industry, compromises their prosperity, upsetting natural and geogr. phical conditions, to the advantage of the railways and the prejudice of trade.

In proportion as these special tariffs are below the maximum rates, the companies believe that they have the right to profit by the apparent concessions, to impose on the sender either an extreme delay, or the absence of all guarantee against damage, or more or less objectionable conditions of loading or unloading.

It is true that these tariffs are submitted to the supervision of the administration, but it is a fact that there is not an example of a proposed tariff, which has not been approved by the Government. The small publicity given to the actual state of things, the want of combination amongst the most interested in reform, the complication of the numerous tariffs, and we must add the indifference of the public who submit to the present state of things, are the causes why an alteration has not been enforced.

It is against this state of things that the founders of the new Society intend to oppose themselves. They hope, that in collecting their joint interests, in exercising a surveillance over the tariffs, in bringing before the attention of the Government the requirements of the public, they will be able to obtain from the various companies a more favourable condition of things.

Already a great number of merchants and producers have joined the association, which will publish each month a special bulletin devoted to the study of questions of transport. The development of this Society would have been more rapid had it not been hindered by the war, and by the Commune. We cannot but approve of the object it has in view. It is a new manifestation of vigour, and we wish it all success.

Street Improvements.

The substitution of macadam for pitched roads is continued actively in Paris. The city, desirous of reducing the expenses of maintenance, which rise in certain places to 16 francs the square metre of paved roadway, are adopting pavement, the maintenance of which costs only 1.75 francs the square metre. It is true that the expenses of first establishment are much greater for the pavement than for the macadam, but there exist in store nearly 20,000,000 of granite setts, and these are being turned to useful and profitable account. The alteration is being fast effected on those roads where the repairs are most costly, and it will be continued according to the decrease in the maintenance expenses, but the macadam will be preserved on those roads on which the traffic is light and the wear in proportion.

Phosphoric Bronze.

We have already noticed a communication made to the Academy of Sciences by MM. Montefiore-Levi and Kunzel, on the use of phosphoric bronze in casting guns. To-day MM. de Ruols, Inspector-General of Railways, and A. de Fontenay, publish a claim of priority on the subject of this discovery. They prove, by voluminous evidence from letters and documents, dating from 1854 to 1859, that they were investigating the identical question, and that during these six years, continuous experiments were made by the artillery service in several foundries and ordnance yards.

The processes have been investigated from the most practical point of view, and in the completest manner, and the results obtained have been satisfactory. Reasons, entirely foreign to the merits of the discovery, put an end to the experiments. The gentlemen named, consider that in such a matter it is their duty to maintain that silence concerning their processes that they have kept from the commencement. They desire simply to call attention to what they have done, long prior to the recent experiments, and to call again the attention of the Administration to the experiments they have made to prove that valuable service could be rendered in recasting of bronze guns.

This question is at present attracting much attention, both from officers and engineers. The propriety of the creation of a new gun is discussed; the technical journals study these military matters attentively, and the Society of Engineers also occupy themselves with them actively.

STRAINS ON ARCHES.

At the meeting of the Institution of Civil Engineers held on the 5th inst., Joseph Cubitt, Esq., Vice-President, in the chair, the paper read was "On the Stresses of Rigid Arches, and other Curved Structures," by Mr. William Bell, M. Inst. C.E. Of this paper the following is an abstract.

The author, after adverting to his method* of constructing a curve of equilibrium for an arch unequally loaded with continuous or discontinuous weights, or under oblique pressures, proceeded to apply it to the determination of the stresses on rigid arches and other curved structures.

As the consideration of an arch of masonry was more simple than that of a rigid arch, a preliminary illustration was given by an examination of the Pont-y-tu-Prydd, an arch of small stability, with the peculiarity that its spandrels were constructed with cylindrical openings. The effect of these openings was described. To shown the nature of the change of the curve of equilibrium by oblique pressure of the backing, this curve was drawn on the supposition that the backing was a perfect fluid, pressing at right angles to the back of the arch. The action of a passing load in increasing the stress upon the masonry was also examined.

The stresses of a rigid arch had hitherto been a subject of considerable difficulty, owing to the intricate nature of the mathematical analysis it was necessary to employ; and the labour of applying formulæ to trace the variation of stress from point to point was considerable. Still, before the transverse sections of arch ribs could be proportioned to the stresses coming upon them, a knowledge of this variation was indispensable.

The main object of the paper was to show that the stresses at every point of an arch rib could be determined by a diagram, and that some questions, such as where the form of the rib was neither circular nor parabolic, and when the pressure was oblique, which would be almost intractable by analysis, could be readily solved.

The curve of equilibrium being the locus of the resultant of all the outward forces, the bending moment was the pressure in the direction of the curve multiplied by the perpendicular upon the tangent. The curve having been determined, the stress caused by the bending moment could be ascertained, and this, added to the uniform compression, was the total stress at any point. By shifting vertically the positions of the points of the curve at the crown and springing, the stress could be indefinitely varied, and the curve could be made to satisfy the conditions of the rigid arch or invariable span, or the rigid arch with the ends fixed.

These conditions were then investigated, and gave the following results. The neutral line of the arch rib having been divided into equal parts, and the bending moments at each of these parts obtained from the curve of equilibrium, when the ends were fixed the sum of all the bending moments had to be made equal to zero; when the rib was of invariable span, the sum of the bending moments, each multiplied by the vertical ordinate of the point to which it corresponded, had to be made equal to zero; and when the ends were fixed and the rib of invariable span, the above conditions had both to be satisfied. When the section of the rib changed from point to point, each bending moment was to be divided by the moment of inertia of the cross section corresponding to it, before entering it in the summation. It was then remarked that where the curve of equilibrium touched the surface of the rib, the compressive stress was doubled, trebled, or quadrupled, according as the section was I or box-shaped, tubular, or of the form of a solid rectangle. For vertical forces only, the bending moment at any point was equal to the horizontal thrust multiplied by the length of the vertical line between the curve of the rib and the curve of equilibrium.

A mathematical investigation was entered into for a circular rib, considered as a voussoir arch, or rigid arch with the ends fixed, in a similar manner to Mr. Airy's treatment of the circular rib of invariable span. It was shown that the stresses could be equally well ascertained by diagram, as by mathematical investigation. When a moving load was the only force acting on an arch rib, the curve of equilibrium was two straight lines, meeting in an apex vertically above the load. As the load moved, the locus of this apex depended on the condition of the rib, as to whether it was rigid, or in the state of a voussoir arch. The action of a uniformly distributed load was then examined, and the circular rib compared with the parabolic. It was remarked that a straight or curved girder might be considered as an arch of any rise, but without horizontal thrust, and it was shown that, by drawing any curve of equilibrium for the weights, continuous or discontinuous, acting on the girder, considering it as an arch, the stress at any point was the horizontal thrust multiplied by the vertical ordinate.

The action of oblique forces was then entered into, and the case of the curved gates of the Victoria Docks was examined.

The stresses on the elliptical caissons used in the foundation of the Thames Embankment were next ascertained by construction. It appeared that when the eccentricity of an ellipse under normal pressure was small, the curve of equilibrium was nearly a circle, whose radius was the mean between the length of the major and minor semi-axes of the ellipse; and that if a boiler, which was an arch in tension instead of in compression, were not truly cylindrical, there would be considerable transverse in addition to the tangential stress, and if the deviation from an exact circle were greatest at the rivetted joints, the stress would be greatest at the weakest parts. It was then remarked, that at an ordinary lap joint, or at a part where the deviation of form amounted only to half the thickness of the plating, the stress at the surface of the iron was four times that due to the uniform pressure of the steam. This result, which showed how greatly a boiler might be weakened by an imperfection of form too slight to be detected by the eye, was not, in the author's opinion, generally known. There could be little doubt that incorrectness of form, the evidence of which was destroyed when a boiler exploded, was one of the chief causes, and hitherto an unsuspected cause, of many of the boiler explosions which occurred from time to time throughout the country.

The last example chosen was the somewhat complex case of the roof of the St. Pancras Station, Midland Railway. The form of the rib differed from the circle and parabola, the section varied to some extent near the springing, and as the action of the wind on the roof was considered, the question was also one of oblique forces. The curves of equilibrium for the roof, acted on only by its own weight, were first drawn. For the actual condition of the rib, namely, that of a rigid arch with the ends fixed, the curve was contained everywhere within the depth of the rib. For a pressure of wind of 40 lb. per square foot, the curve showed two maximum stresses of 4.08 tons and 4.14 tons per square inch.

The arch rib had been treated as of invariable span, but real or virtual alterations of span might be caused by changes of temperature, a yielding of the abutments, and the compressibility of the arch rib itself. It became then an important practical question to determine, for wrought iron arches, how much the stresses might be altered by a small alteration of the span. The method of ascertaining this generally was then described, and it was found that a wrought-iron rib of 200 ft. span, 20 ft. rise, of an I or box-shaped section, and loaded uniformly, might have the stress at the crown increased from 4 tons to 6¼ tons per square inch. This would happen if the abutments each yielded ¼ in. under the thrust, and the temperature were reduced 60° below that at which the parts of the rib were put together. This result included the stress caused by the compressibility of the iron.

In order to draw the elastic curve of the rib, it was then shown how to find the displacements of the different points, by change of temperature, compressibility of the metal, and action of the bending moment. The deflection of the crown was the alteration of the rise of the rib as found by this process. Applying it to the case of the rib of the St. Pancras Station roof, the deflection of the crown was found to be .2 in., while observation had given from $\frac{1}{16}$ to ¼ in., so that the agreement of calculation with observation was very close.

The author proposed to measure stresses by direct observation of the extension or compression of a small length of the material of a structure. For a stress of 1-5th ton per square inch, the extension of a length of 50 in. of wrought iron was $\frac{1}{1000}$ of an inch, which, if magnified fifty times, would be read as $\frac{1}{20}$ of an inch by the eye. During the testing of a structure, two microscopes, magnifying fifty diameters, with scales in their eye pieces, fixed about 50 in. apart, would measure stresses of 1-5th of a ton per square inch in the most direct manner, and the stresses could be measured at the critical points of a structure.

The author thought that this method of observation might even be useful in another way; if, as was probable, inferior kinds of wrought iron approached to cast iron in the scale of their extensibility under moderate stresses. By taking an observation the stress could be accurately determined by calculation, the quality of the iron which had been used in a structure might be ascertained.

* *Vide* Minutes of Proceedings Inst. C.E., vol. xxxi., pp. 145-148.

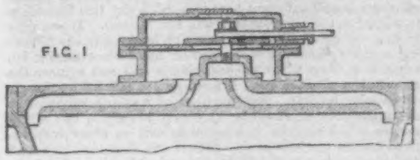
Canadian Railways.—The Toronto, Grey, and Bruce line has been formally opened to Orangeville. Application will be made to the local legislature of Ontario next session for a charter to authorise the construction of a railway from a point near King station on the Northern Railway to Angus *viâ* Schomberg and Alliston. In Novia Scotia, a movement has been made with a view to the formation of a company to construct a line from Annapolis to Yarmouth. The New Brunswick Government has accepted a proposition of Mr. E. R. Burpee and others to build the Rivière du Loup Railway. The line is to be on the narrow gauge, and the company formed for its execution is to receive a subsidy of 10,000 acres of land per mile; operations will be commenced at Fredericton immediately.

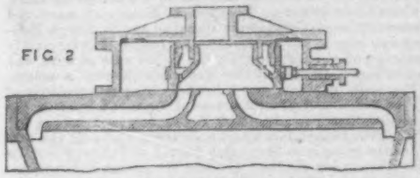
The Cerberus's Guns.—The *Melbourne Argus* gives a long account of two days' shooting from the four 10-inch 18-ton guns of the low freeboard monitor Cerberus, recently sent out as a colonial defence ship. From this we gather that the shooting on both days was bad, and that only two shells out of all that had been fired since the Cerberus's arrival in the colony had burst when desired. As the guns are believed to be faultless, and the Scott carriages answered admirably, the fault must lie in the projectile and its fuse, and in the want of proper means of ascertaining the distance, which varied from 2500 to 3700 yards. On the first day, five shells were fired, of which only one reached its intended destination, and none burst as desired. On the second day, six shells were fired, of which only two fell near the target, and only one burst. As observations were not taken at right angles to the range, even the good results obtained are doubtful. We are not told how many "noisy" shells were fired, but none broke up prematurely, and only one burst out of eleven. Invulnerable ships with monster guns, the shells of which do not hit the object, or hitting do not burst, are very inoffensive war machines. Something more is evidently wanted.

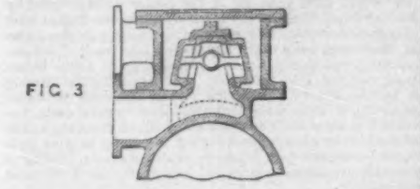
RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 3350, 10d.) Francis Jackson, of Stainburn, near Workington, patents several arrangements of equilibrium slide valves. The annexed sketches show three of Mr. Jackson's plans, and will serve to explain clearly their chief







features. It will be seen that according to the plan shown in Fig. 1, the downward pressure on the valve is intended to be balanced by the upward pressure on the plate covering the opening in the back of the valve chest proper.

(No. 3357, 10d.) James Willoughby, William Willoughby, Joseph Willoughby, and, Samuel Willoughby, of Plymouth, patent arrangements of steam stamping machinery for breaking ores, &c. We could not describe these plans here.

(No. 3358, 8d.) Henry Burgess Young, of Instow, patents some neat and ingenious arrangements of feathering gear for screw propellers. Mr. Young exhibited a model of one of his plans at the last Conversazione of the Institution of Civil Engineers, when we noticed it briefly.

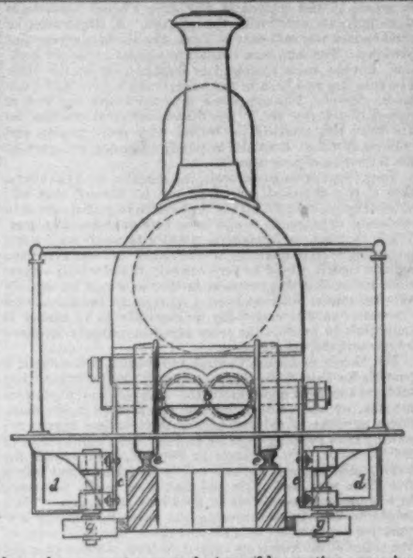
(No. 3360, 1s. 4d.) Andrew Stewart, James Stewart, and John Wotherspoon, of Coatbridge, patent machinery for making welded tubes, this machinery being adapted for effecting at a single operation, the bending of the flat plate or strip into an overlapped or butt-jointed tube or skelp ready for the ordinary welding process.

(No. 3365, 10d.) Andrew Bell, of Howley, near Huddersfield, patents a modification of Green's well-known "economisers." Mr. Bell produces to substitute helically coiled pipes for the straight pipes employed by Mr. Green, each helix being traversed by a vertical axis provided with arms carrying scrapers. These scrapers are made to act upon the pipes by giving the axis a slow rotary motion by suitable gearing. The pipes forming the several helices are connected to each other and the water to be heated is pumped through them as in Green's economisers.

(No. 3371, 10d.) Nathaniel Clayton and Joseph Shuttleworth, of Lincoln, patent the arrangement of wheel for traction engines, &c., which we illustrated and described on page 197 of the present volume.

THE following specifications of completed patents are all dated within the year 1871; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 1, 1s.) John Barraclough Fell, of Sparke Bridge, near Ulverstone, patents an extraordinary arrangement of locomotive for narrow gauge railways. Mr. Fell proposes to mount the rails which carry his engines above the ground level, and to attach to the outer sides of the beams or girders which carry these rails, a supplementary pair of rails, which are to be pressed against by horizontal wheels, as shown in the annexed sketch. The side frames of the engine, it will be noticed, descend below the level of the carrying rails, and carry the bearings for the axis of the horizontal wheels. The latter wheels are not driven by the engine, and Mr. Fell appears merely to contemplate their use as guide wheels. Mr. Fell states that the object of his invention is to "use only one boiler, and yet bring down the centre of gravity of the engine lower than in those of ordinary construction, whereby greater steadiness and stability is obtained when running"! Whether it is worth while doing so much to gain so little, is a point regarding which we and Mr. Fell hold very different opinions. As a scheme for necessitating the construction of an expensive and ridiculous

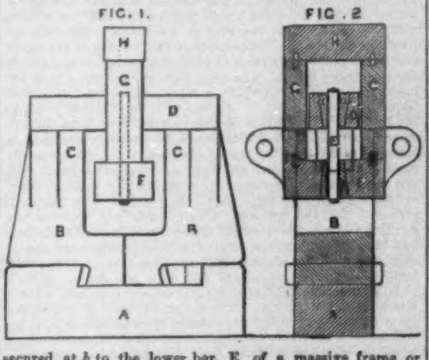


form of permanent way, and a type of locomotive possessing no practical advantages, Mr. Fell's plan is admirable.

(No. 12, 10d.) George Arthur Fernley, of Stockport, patents an arrangement of flues applicable to Butterley boilers. According to these plans the product of combustion, after being led from the fire through tubes traversing the boiler to the hind end, are led back through a lower set of flues, which stop short before reaching the end next the fire-grate, and dip down so as to communicate with a flue beneath the boiler.

(No. 16, 10d.) James Willoughby, William Willoughby, Joseph Willoughby, and Samuel Willoughby, of Plymouth, patent arrangements of steam-stamping machinery for breaking ores, &c, which we could not describe briefly. We may mention, however, that the plans include a mode of applying Justice's "dead-blow" hammer to the above-mentioned purposes.

(No. 17, 8d.) Joshua Jeavons, of the Millwall Steel and Iron Works, patents a mode of testing the power of samples of steel or iron to resist suddenly applied tensional strains. For this purpose Mr. Jeavons proposes to secure the sample, E, to be tested in the manner shown in the annexed sketch. From the latter it will be seen that the upper end of the sample, E, is fixed by the wedge-shaped jaws, *a*, to the crossbar, D, of an anvil, B; while its lower end is similarly



secured at *b* to the lower bar, E, of a massive frame or stirrup, F, G, H, which encircles the crossbar, D. The blows of a steam hammer being applied at H, it is evident that the sample will be subjected to suddenly applied tensional strains, and its behaviour under such strains can be readily noted. The sides and top and bottom bars of the frame, F, G, H, are connected by dowels, so that they may be readily taken apart and put together.

(No. 25, 1s.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of George Taylor, of Constantinople, a mode of converting reciprocating into rotary motion by causing a pair of detents on a vibrating lever to act alternately on the two plies of an endless pitch chain passed over suitable chain wheels, one of these wheels being fixed on the axis to which it is desired to give motion. This arrangement might prove useful in some instances, but it is likely to have a very limited application.

(No. 29, 8d.) William Blane Mack, of Philadelphia, U.S., patents placing beneath the main body of a steam boiler, a series of parallel horizontal tubes, these tubes being disposed so as to form a kind of arched roof to the furnace. The tubes are coupled at their alternate ends, and the lower and the upper of the series are connected with the boiler by pipes leading to the lower and upper parts of the water space respectively. It is considered by Mr. Mack that this arrangement will improve the circulation in the boiler; it is considered by us, however, that it would come to grief after being a short time in use, and that its effect on the circulation would be very doubtful.

(No. 31, 10d.) Edward Hodson and Richard Hill, of Bolton, patent another of those tappet arrangements which have been so often proposed for informing a locomotive engine driver that he has passed a signal which is against him, and for applying the brakes if necessary. Our opinion of such contrivances has been frequently stated, and we need merely remark, therefore, that the plans proposed in the patent under notice are no better and no worse than dozens of similar schemes which have preceded them.

(No. 33, 1s. 6d.) Edward Thomas Hughes, of 123, Chancery-lane, patents, as the agent of Hubert Root Ives, of New Haven, U.S., arrangements of presses for compressing plumbago into cakes, &c. We could not describe these plans briefly.

(No. 36, 2s. 10d.) Frank Norton, of Beeston, and John Storey Davies, of Manchester, patent a variety of forms of water-tube boilers, which they propose to employ for stationary, marine, and portable engines. These plans are worthy of the notice of those interested in this class of boiler, but the modifications comprised in the patent are too numerous for us to attempt to describe them here. The patent also includes a form of feedwater heater, in which the water is lifted by small buckets, and allowed to fall through the steam by which the heating is effected.

(No. 64, 1s. 10d.) William Bouch, of Shildon, near Darlington, patents arrangements for retarding locomotive and other engines by applying pressure against the pistons. This is a very efficient modification of M. Le Chatelier's plan; but as we intend to illustrate it fully in an early number, we need not describe it here.

(No. 66, 3s. 8d.) Abraham Lismann, of Munich, patents numerous arrangements of machinery for rolling and shaping metals. Descriptions and illustrations of some of the principal of these machines have already been given by us on pages 232 and 277 of the present volume.

(No. 67, 10d.) John Norman, of Glasgow, patents a machine for planing off the fins formed on tubes during the process of manufacture. The details of the machine appear to be well worked out.

(No. 69, 8d.) George Haseltine, of Southampton-buildings, patents, as the agent of Alexander Lyman Holley, of Brooklyn, U.S., modes of casting iron and steel ingots, &c., of which we shall probably have something to say in a future number.

BOILER INCRUSTATION.

THE following report on boiler incrustation was presented and read at the recent meeting of the American Railway Master Mechanics' Association, held at Louisville, Kentucky, on the 12th of September last.

The Committee to whom was referred the subject of Boiler Incrustations would respectfully report that they prepared and issued, through the secretary of the Association, a circular of questions to all of the master mechanics of various railroads throughout the country, in order to elicit such and all information they might possess on this subject. In compliance therewith, communications have been received from forty master mechanics; and although the number is small compared with the whole number of roads, yet it is nearly double that of any previous year, and the information so obtained is correspondingly extensive and valuable, confirming in substance the theory advanced in a paper read in convention on this subject last year, to the effect that the only effectual way to prevent incrustation is to purify the water, if possible, before it is allowed to enter the boiler. To this end your Committee has directed its efforts, and given special attention to the reports of those who have experimented with a view thereby of ascertaining the best and cheapest mode of accomplishing the same. The opinion of others will be referred to in this report.

From all communications received it is found that most roads located in the Eastern and Southern States are troubled but little with incrustation, while those in the Middle States are variously affected, some suffering greatly, others none at all. Western roads suffer most, many of them finding it necessary, in order to maintain average economy in fuel and reasonable safety to the boiler, to take out flues once in six to twelve months for the purpose of removing scale from both boiler and tubes.

Mr. Cushing, of the Kansas Pacific Railway, and Mr. Johann, of the Pacific Railroad of Missouri, and others in Missouri, Illinois, Iowa, Wisconsin, Michigan, Indiana, and other Western States, realise similar difficulties, in a greater or less degree, according to location. Mr. DeClereq, of the Toledo, Peoria, and Warsaw Railroad, reports having used batteries, and also many different kinds of powders for the removal of incrustation, and all without any decided results. He finds distilled water the best of anything he has ever used to prevent lime incrustation. He thinks good soft water, well filtered, will keep a boiler free from mud and scale.

Mr. Ham, of the New York Central, says he can run with economy on Eastern Division four years before taking out flues, while on Middle Division, on account of lime and scale, he has to take them out on an average every year and a half, and on the Western Division every two years. Finds it necessary on Middle Division to put new sheets in bottom of cylinder part of boiler on an average every five years, and with good water has only repaired that portion of the boiler once in eight to ten years. Has used batteries and powders, but finally abandoned them all. He is troubled with deposit of scale on crown sheet; gives crown bars 1 in. clearance, and considers it as good as more space. He knows of nothing equal to good pure soft water to keep boilers free from mud and scale.

Many others report having used batteries, powders, &c., from which they failed to discover any good results, making almost a universal condemnation of so-called boiler anti-incrustators.

Mr. Sedgley, of the Lake Shore and Michigan Southern Railway, states that on some sections of his road impurities in the water will destroy bottom of boiler after three years' service, while on other sections that portion of the boilers is good for ten years.

Mr. Towne, of the Hannibal and St. Joseph Railroad, finds it economy to take out from thirty to fifty flues after six months' service to remove soft sediment and disengaged scale, and at the end of one year (if possible to lay up the engine) flues are all taken out and treated as before stated. In some instances he has found the flues, after six months' service, coated with hard scale to a thickness of nearly ½ in., and after twelve to eighteen months' service it is frequently found from ⅛ in. to ¼ in. on both flues and boiler. He makes a practice of renewing more or less of lower portion of cylinder part of boiler, as often as new fire-boxes are required, after from four to eight years' service. Has taken out sheets after less than ten years' service that were corroded nearly through in spots.

Mr. Philbrick, of the Main Central Railroad, states that he never takes out flues until boilers need repairs, having some twenty-three years old, still good, while some have needed repairs after six years' service. He does not state whether the latter gave out from the effect of incrustation or defective iron.

Mr. Foss, of the Vermont Central Railroad, reports running flues ten years without taking them out. His boilers that have run eighteen years still good.

Mr. Keeler, of Flint and Pere Marquette Railroad, which reports very bad water, has found it necessary to take out flues as often as twice in one year, and in some instances remove fire-box in less time than one year. He finally adopted the plan of leaving out bottom row of flues and washing boiler thoroughly through with steam force pump through the front sheet as often as once a week, since which time he has only taken out flues once in three or four years. Mr. Lauder, of the Northern Railroad of New Hampshire, reports very little incrustation; never takes out flues to remove scale. Has found very little scale on flues that have run fifteen years. Has shells of boilers that have been in service twenty years without repairs or leakage.

Mr. Sellers, of the Memphis and Charleston Railroad, says he has just taken out flues that have been running thirteen years, finding them coated with less than ⅛ in. of scale. Mr. Garfield, of the Hartford, Providence, and Fishkill Railroad, says they have engines that have run sixteen years, with copper tubes that have never been taken out. Mr. Young, of the Cleveland, Columbus, Cincinnati and Indianapolis Railroad, reports that he can only run flues one year, and boilers from five to ten years, without removal. Mr. Freeman, of the Macon and Western Railroad, Georgia, reports no scale; never takes out flues until boiler is condemned. They have engines that have been running twenty-three years without repairs of boilers.

Mr. Boon, of the Pittsburg, Fort Wayne, and Chicago Railway, reports using surface, well, and Lake Michigan water, chiefly the former, in which he finds impurities, consisting largely of mud, with sufficient lime to hold it together, forming a hard substance. He does not consider it economy to run flues longer than from twelve to fifteen months, or from 40,000 to 50,000 miles, before taking them out to remove scale. He finds that impurities in the water will eat out the bottom of new boilers after about six years, or 180,000 miles' service, so as to require new sheets. He says: "I find in my experience that boilers that have braces rivetted, or machinery bolted to lower part of (same, eat out much more readily than those that have no fixtures on this part of the boilers." This is also the experience of others. It is found that wherever the skin of the iron is broken by the use of screw bolts or otherwise, the process of corrosion first commences, and progresses much more rapidly than it does around well driven rivets, because the screw leaves the internal surface of the boiler quite ragged, exposing the fibres of the iron to the alkalies contained in the water. In rebuilding, Mr. Towne, of the Hannibal and St. Joseph Railroad, has substituted bridges in place of braces to support the boiler between fire-box and smoke arch, and he can see no objection to this plan. Braces are fastened to frames in the usual manner, and connected at the top by means of a plate fitted to the circle of the boiler, which answers only as a rest for the boiler and a lateral support to the frame. Mr. Boon believes that in the West fully 70 per cent. of boiler repair is caused by the use of impure water. He thinks it would be a great saving to filter the water at tank before it is taken into the tenders. From actual experiments he has found that the use of rain water will quickly and effectually remove incrustation. This result has also been the experience of others who have tried it.

Mr. Street, of Western Division, Pennsylvania Railroad, reports that water on said division is strongly impregnated with lime, sulphur and fire-clay; does not believe it will pay to take out flues simply to clean off scale; has found, on removing scale from tubes that have been running less than three years, places eaten entirely through the iron, varying in size from a needle point to ¼ in. along the entire length of the tube. Other master mechanics report similar results. Mr. Street is now experimenting with a compound, "which precipitates at once the carbonates, the sulphates, and the silica, converts the grease into soap, and neutralises all acids, removing all old deposits of whatever kind and however thick, and at the same time not attack either iron or copper. It acts not only at an elevated temperature, but precipitates and neutralises in cold water all these foreign bodies." He says: "My experience so far has been as follows: Have made in an iron vessel 100 lb. of the mixture, in which I have immersed a quantity of ⅛ in. sheet copper, a piece of hard limestone weighing 2½ lb., a piece of common sandstone of same weight, and a portion of an old flue to which is adhering a scale over ⅛ in. thick. After allowing the stones to remain in the compound four days I found them to be thoroughly saturated with the mixture. A slight blow of the hammer was sufficient to crush the limestone into fine particles. The sandstone crushed to powder under my boot-heel, but the scale remained as hard as ever on the tube. The tube has now been in the mixture seven days, and I can see no change. The compound does not attack the iron or copper that I can see." Mr. Street further states that he has tried this mixture in boilers with good results, and believes it will at least aid in purifying water and prevent the formation of new deposit.

Your Committee would state, in connexion with the above, that if any chemical compound can be devised that will effectually precipitate all the impurities in cold water, at a moderate expense, it would be a very valuable discovery. While they believe it might be possible to purify cold water possessing certain qualities by a chemical process, it is their opinion that it would be very difficult, if not wholly impossible, to devise such a common method as would be equally effectual on the different lines of railroad, for the reason that the waters vary so essentially in character as to render it impossible to produce the same result in different locations by one and the same process.

Mr. Hayes, of Illinois Central, reports that whenever it is possible for them to lay up an engine for that purpose, they take out the flues and remove the scale once in about four months, or when an engine has run 8000 to 10,000 miles. Some portions of cylinder part of their boilers require renewing after running from six to ten years; eight years, or 200,000 miles, may be taken as the life of this part of the boiler. He knows of but one way to keep locomotive boilers free from mud and scale, and that is to purify the water in a separate vessel before it goes into the boiler. "This might be done by decomposing the water, by bringing it in pure jets into contact with either exhaust or live steam from the boiler of the pumping engine, or from a boiler provided expressly for this purpose, allowing the mud, lime, &c., to attach themselves to plate or other surface provided to receive them. This system has been in use for several years on our stationary engines at these shops (Chicago) and works admirably. But very little foreign matter goes into the boiler, and the water is furnished at about 208 degrees, so as to produce a very marked saving of fuel. If this system is considered too expensive to apply to water tanks generally, it might be tested at points where water is particularly troublesome, until some means are adopted to purify the water before it enters the boiler."

Together with the above, Mr. Hayes has kindly furnished the Committee with copies of letters to his President, Mr. Newell, recommending a plan for purifying water for locomotive use which is in substance as follows: "Incrustation motive use which is in substance as follows: should be transferred to some other vessel made for that purpose, for a locomotive boiler is not constructed to admit of the ready removal of incrustation; nor can it be so constructed and prove efficient for all that it is designed to do, including the ready removal of incrustation, without considerable increase in the cost of construction; but if a vessel is constructed for the express purpose of receiving incrustation from water, and allowing their removal at pleasure, locomotive boilers will be kept free from these troublesome and expensive formations. Such a vessel may be constructed of wood or iron. If wood, it may be fitted with scrap iron, as in the heater for the stationary boiler before referred to. The impure feed water, in this case, is admitted through a perforated pipe into the top of the heater, and runs down over the scrap iron, meeting in its descent, the exhaust steam in the ascent. The result is the boiling of the water and forming of incrustation on the hot scrap iron instead of in the stationary boiler. The water is then discharged from the lower part of the heater into a filter, where its suspended impurities are deposited. From the filter it is pumped into the boiler. Without this heater incrustations were formed in one month in the boiler equal in quantity to what is formed in six months using the heater." He suggests making the experiment at Weldon, by purifying sufficient water for two engines employed in the yard, or on short runs, so that both engines can take all their water from one tank provided for the purpose, which tank will contain the purified water. The conduct of the water in the two boilers can be watched, and the cost of purifying the same can be obtained with accuracy. The experiment will cost about 1000 dols., of which about 600 dols. will be for a tank 20 ft. in diameter, 225 ft. of 3-inch cast iron pipe, and a No. 4 Knowles steam pump. These can be used at any other point on the road if the experiment is unsatisfactory. This will leave actual cost of experiment but 400 dols., to which would be added about 2 dols. per day for fuel in stationary boiler while the experiment is being conducted.

Your Committee most heartily indorse the views of Mr. Hayes in relation to the foregoing, and would respectfully urge the attention of railway companies to the subject of an experiment as suggested by him, to be tried by Illinois Central, or some other railroad company, for the mutual benefit of all others interested. There can be but little doubt of the success of this method of purifying water. Assuming that lime and other impurities held in solution will precipitate at a boiling temperature of 212 degrees, then all suspended impurities can be readily removed by filtering. The process of filtering should be thorough, so that no floating impurities will pass into the boiler and there lodge upon the flues and internal surface of the same in the shape of hard mud or semi-scale. This accumulation was observed by Mr. Towne, of the Hannibal and St. Joseph Railroad, in two four-flue boilers employed at the company's shops in Hannibal. The two boilers are supplied with water from the Mississippi river, which passes through a Stilwell and Pierce heater before reaching the boilers. The heater seems to perform its work well in arresting impurities held in solution, having formed on the shelves of the heater, after two weeks' service, an accumulation fully 2 in. thick, composed, in appearance, of about two parts mud to one part lime. This was during a season of high water. At an ordinary stage the water is clearer, and consequently a less deposit in the heater, composed principally at such times of carbonate of lime. After passing over several shelves the water reaches a filter situated in the lower part of the heater, from which it is pumped into the boiler. The filter is composed simply of hay or straw, and occupies a place provided for it—about 2 ft. square and 12 in. deep—the whole arrangement being quite inefficient, hence the water passes into the boiler in a muddy state, where it together with such other impurities as may have passed through the heater, attaches itself to the heated surface within the boiler, forming a white pasty substance, which in the absence of water, while the boilers are still under the pressure, or even after the pressure has passed off, there is still sufficient heat to quickly dry this formation to a hard scale that washing will not remove. It can only be removed by frequent and thorough washing in the following manner: Let the water out of the boilers after it becomes cool, then while the sediment is still soft remove the man-head and wash with a force-pump, assisted by the use of suitable brooms. But his plan of washing occupies so much time that it would be necessary to employ two sets of boilers, which railroad companies as well as other corporations seldom feel able to do. Boilers are, therefore, blown off under pressure to facilitate the removal of floating substances, which causes priming. This plan of blowing off was found necessary at the shops of the Hannibal and St. Joseph Railroad as often as two or three times a week, besides frequently blowing off at intervals while the boilers were at work, and as thorough washing as time would permit once a month. The result, after two years' service, was an accumulation of incrustation fully ½ in. thick, resembling that taken from the heater—lime, mud, &c. Mr. Towne says: "I believe but very little incrustation would have accumulated in this case had the water been thoroughly filtered and allowed to settle before entering the heater, so that the process of decomposition would have gone on in the heater uninterrupted by floating impurities, thereby reaching the boilers free at least of organic matters. The water, after reaching its receptacle in the heater, has a milky appearance (the result of decomposition), and should, therefore, have time to settle before being pumped into the boiler. I believe, also, the forming of incrustation by the drying process (blowing off under pressure), is more dangerous than hard mineral scale, because it is more likely to crack and flake off from the action of the heat or a heavy jar, allowing the water to come suddenly in contact with intensely heated surfaces, causing a successive repulsion sufficient at least to rupture if not burst the boiler."

Regarding scale and deposit of sediment, the Committee of the Franklin Institute say: "The undue heating of parts of a boiler may be produced by deposit." No cause of undue heating is better made out than this. The least that can happen after the accumulation of sediment is the injury of the boiler, perhaps its bursting, and a true explosion may result. Two violent explosions at Bowers' Mill and at McMickle's in Pittsburg, are fairly attributable to the effect of sediment, and there does not appear, in either case, to have been a deficiency of water. M. Arago mentions an instance of a rent made in a boiler at Paris, by the accidental resting of a rag on the bottom of the boiler; but for occupying too much time of the convention many illustrations of a similar kind might be referred to, showing the detrimental and dangerous effect produced by the use of impure water in steam boilers.

In conclusion, your Committee would state that, in their opinion, until some means are devised to purify water for locomotive use, the best that can be done is frequent and thorough washing with force-pump or otherwise. Frequent blowing off of a half gauge (more or less), of water while the engine is at work, through a cock arranged for that purpose in a mud drum rivetted to the bottom of front sheet of cylinder part of boiler, is the best way of getting rid of mud and other loose deposits in that part of the boiler. Crown sheet may be kept free from loose deposit by washing off frequently with force pump through holes arranged for the purpose inside of boiler (or wagon top), just above the crown sheet. It is the opinion of the Committee that there should not be less than 1 in. clearance between crown sheet and under side of crown bars, in order to obtain a better circulation of water. Some roads (Illinois Central and Hannibal and St. Joseph), are leaving out the thimbles formerly placed around the crown bolts, and at present there seems to be no objection to the practice.

Other experiments than those already named are being tried which are not yet sufficiently developed to justify any report upon them at this time, but your Committee hope that they may result in eliciting something of sufficient practical value to appear in the next annual report.

Respectfully,

H. A. TOWNE, Hannibal and St. Joseph Railroad.
J. M. BOON, Pittsburg, Fort Wayne, and Chicago Railway.
C. O. MARSTON, Indianapolis, Cincinnati, and Lafayette Railroad.
} Committee.

RUSSIAN TELEGRAPHY.—A new telegraphic treaty has been concluded between Russia and Persia. As a consequence of the new arrangements agreed upon, preparations are being made for the construction of a number of the new lines of telegraph along the Lower Volga and the Caspian Sea, radiating from Astrakhan as a common centre.

THE AUSTRALIAN MAILS.—An Intercolonial Conference which has been sitting in Melbourne has agreed upon a scheme of ocean postal communication, including a service between Suez and Sydney, by way of Galle, Adelaide, and Melbourne, and a service between Melbourne and California, calling at Moreton Bay and Sydney with a branch to Tasmania. The total cost of the service will be about 246,000*l.* per annum, and it is proposed that one moiety of this amount shall be borne by the Imperial Government.

LITERATURE.*

Narrow-Gauge Railways. By C. E. SPOONER, C.E., F.G.S. London: E. and F. N. Spon. [Price, 12s. 6d.]

As engineer of the celebrated Festiniog Railway, Mr. Spooner has a special claim to attention when he writes on narrow-gauge railways, and, knowing as we do his practical experience, it is with a feeling of disappointment that we find a large proportion of the work under notice is not written by Mr. Spooner at all. Beside reprinting some papers, of which he is the author, Mr. Spooner has deemed it advisable to reproduce from this journal, from the *Times*, and from *The Engineer* a variety of articles relating to narrow-gauge railways in general, and the Festiniog line in particular. There is no doubt that he has in this way laid before his readers the views of a number of different writers on the subject to which his book relates, but he has done this at the expense of introducing numerous repetitions of the same information, and he has thereby marred a work which we feel certain most of his readers would have preferred should relate to his own views and experience alone.

The book commences with a reprint of the paper "On Narrow-Gauge Railways," read by Mr. Spooner before the Inventors' Institute in 1865, a postscript being added directing attention to some points respecting which the author has modified his opinions since the date just mentioned. Thus Mr. Spooner points out that further experiments made on the Festiniog Railway have proved to him that the carrying capacity of the rolling stock may safely be made considerably greater in proportion to the width of the gauge than he deemed advisable in 1865, and that the introduction of the Fairlie engine has shown that narrow-gauge railways may now be considered to have a far greater power of accommodating traffic than was the case formerly. Finally, Mr. Spooner states that the engine he proposed in 1865 may be considered to be supplanted by the Fairlie engine, and he remarks of the latter that it "embraces all the desiderata then, as now, deemed necessary for economically-worked railways."

The next nineteen pages of the book are taken up by accounts of the Festiniog Railway reprinted from our own pages and those of *The Engineer*, and then follows a paper on the "Festiniog Narrow Gauge Railway and the Fairlie System of Locomotives," read by Mr. Spooner before the Russian Imperial Railway Commissioners. This paper—which is illustrated by three folding plates showing a plan and section of the line, and a diagram of the carriages used—contains a very complete account of the Festiniog Railway and its rolling stock, and it is supplemented by extensive tables giving details of the traffic, the rates charged, the cost of maintenance and working, &c. In fact, the paper is so complete, that it renders the publication of the two articles which precede it entirely unnecessary.

Mr. Spooner next proceeds to give briefly his own views respecting the construction of narrow gauge railways, and it is this portion of the work which we should have liked to have seen much extended. Our author does not recommend so small a gauge as 2 ft. for light railways, but he considers one of 2 ft. 6 in. to be ample. We ourselves differ with him on this latter point, as our readers well know, but we have no intention of discussing the matter further here, as we prefer rather to direct attention to Mr. Spooner's views. Mr. Spooner considers that with a line laid to the gauge he recommends—namely 2 ft. 6 in.—and worked with Fairlie engines, a traffic can be accommodated equal to 75 per cent. of that which can be accommodated on a line of the ordinary gauge of 4 ft. 8½ in.; and he considers that on such a narrow gauge line worked with Fairlie engines having a load of 2½ tons per wheel, and laid with iron rails weighing 55 lb. per yard, or steel rails of 50 lb. per yard, the rails will last twenty years, although the sleepers will require renewing in eight or ten years. For a single line of 2 ft. 6 in. gauge Mr. Spooner recommends a formation width of 9 ft. 6 in., and for a double line a formation width of 17 ft. 6 in. In the latter case the width between the two lines is to be 5 ft. 2 in. This portion of the book is illustrated by woodcuts of sections of cuttings showing the distribution of the space, and by three folding lithographic plates showing outline views of the passenger and wagon stock which Mr. Spooner recommends for 2 ft. 6 in. gauge lines. There are also appended to this portion of the work some tables purporting to give the comparative carrying capacity, dead weight, and paying loads, &c., of trains on lines of a certain character laid to a gauge of 2 ft. 6 in. and 4 ft. 8½ in. respectively; but we regret to say that we must protest against these tables as giving a most undue advantage to the narrower gauge. For instance, in the case of the tables referring to passenger traffic, Mr. Spooner supposes the rival trains to be made up as follows:

2 ft. 6 in. Gauge.

	Tare weight of engines and carriages. tons. cwt. qr.	Passengers carried.
1 Fairlie engine having no tender (in steam)	25 0 0	
6 First-class carriages	9 3 0 ...	72
12 second "	18 0 0 ...	192
20 third "	20 0 0 ...	320
1 guard's brake van	1 13 3 ...	1
1 bogie carriage with 7 compartments and van	5 0 0 ...	55
Engine, driver, stoker, and guard	5 0	
Total passengers carried ...		640
Total dead weight hauled ...	64 tons 1 cwt. 3 qr.	
Total gross weight of train, including 17 tons of passengers' luggage	157 tons 14 cwt. 3 qr.	

4 ft. 8½ in. Gauge.

	Tare weight of engines and carriages. tons. cwt. qr.	Passengers carried.
1 four-wheel coupled locomotive (in steam)	27 0 0	
Tender and fuel	18 0 0	
2 first-class carriages (3 compartments)	12 0 0 ...	36
4 second-class carriages (4 compartments)	20 0 0 ...	128
7 third-class carriages (3 with 5 compartments, and 4 with 4 compartments)	47 0 0 ...	210
1 guard's van	5 0 0 ...	1
1 bogie carriage (with 7 compartments and van)	12 12 0 ...	63
Engine driver, stoker, and guard	0 5 0	
Total number of passengers carried		538
Total dead weight hauled ...	102 tons 17 cwt.	
Total gross weight of train, including 14 tons of passengers' luggage	200 tons 1 cwt.	

It needs but a glance at the above Tables, which we have condensed from those given by Mr. Spooner, to show the false nature of the comparison instituted. It is totally unjust to compare the accommodation afforded by a 4 ft. 8½ in. gauge first-class carriage weighing 6 tons, and carrying but 18 passengers, with that afforded by a 2 ft. 6 in. gauge carriage carrying 12 passengers with a dead weight of 1 ton 10 cwt. 2 qr. Judging from the outline sketches given in the work under notice, we believe that Mr. Spooner has under-estimated the weight of the rolling stock he proposes to adopt for a 2 ft. 6 in. gauge line; but quite apart from this view of the question, the accommodation for passengers afforded by such stock is far from being such as to render it justly comparable with that of ordinary stock on the 4 ft. 8½ in. gauge. If, on the other hand, passengers will be satisfied with the accommodation which Mr. Spooner proposes to give them on the narrow gauge, then carriages affording such accommodation can be built for 4 ft. 8½ in. gauge lines with weights very far below those taken by Mr. Spooner as necessary for that gauge in his comparative Tables. There is also an unfairness as regards the engine power. The engine and tender, weighing together 45 tons, supposed to be used on the 4 ft. 8½ in. gauge, would necessarily carry a supply of fuel and water for a far longer distance than the Fairlie engine supposed to be employed on the narrower gauge; but no allowance is made for this. In the case of the passengers' luggage, also, we find 17 tons allowed for the narrow gauge trains, but, so far as we can see, no provision is made for carrying it out. Narrow gauge railways, worked by Fairlie engines, have, as we have on many occasions pointed out in this journal, so many real advantages, that it is perfectly unnecessary that imaginary advantages should be invented from them; and under these circumstances we cannot but regret that Mr. Spooner should have instituted such comparisons as that to which we have just directed attention. Such comparisons injure a really good cause, and every care should be taken to avoid them.

The Tables we have just noticed, are followed by an account of the experiments made on the Festiniog Railway, in February, 1870, in the presence of the Russian Commission—experiments of which an account was given in our pages at the time—and by a reprint of the articles which appeared in the *Times* of about the same date, under the title of "The Railways of the Future." Next, Mr. Spooner proceeds to point out fairly the advantages of narrow gauge lines, and he accompanies his remarks by a series of plates, giving comparative sections of 2 ft. 6 in. and 4 ft. 8½ in. gauge lines in cuttings of various kinds, embankments, tunnels, &c., these plates including particulars of culverts, and over-line bridges, and being accompanied by Tables of quantities and costs. This is another portion of the work in which Mr. Spooner gives his readers the benefit of his experience, and it is proportionately valuable.

One point dealt with by Mr. Spooner in this part of his book is the important one of transshipment, and we find that he holds the same views as ourselves regarding the cost of this item being generally over-estimated. With proper appliances, he considers that the cost of transshipment from broad to narrow-gauge wagons, and *vice versâ*, will not exceed ¾d. per ton for minerals, and 1½d. per ton for goods, and he illustrates his views by engravings of a very well planned set of transshipment sidings, recently completed according to his designs, at a junction of the Festiniog and Cambrian Railways. We hope at some future time to illustrate fully the arrangements adopted at this junction, but meanwhile we may state that the goods to be transshipped are divided into three classes, namely, slates, minerals, and general goods, and special arrangements are made for each. Thus, in the case of the slates, the ordinary and narrow-gauge wagons are simply brought close together side by side, the rails being laid so that the floor-lines of the wagons are on the same level, and the slates are then shifted by hand. In the case of the minerals, again, the wagons to be emptied are run along a tipping platform above the level of the wagons to be filled, and are emptied into the latter by a neatly-contrived side tipping arrangement, while, lastly, in the case of general goods, the broad and narrow-gauge wagons are brought alongside the opposite sides of a platform furnished with cranes, by which the goods can be simply lifted out of one wagon, and swung round and deposited in the other. The arrangements to which we allude are all very simple, and promise to be very efficient, and, although the costs of transshipment estimated by Mr. Spooner are very low—lower even than we should have been disposed to give them—yet there is no reason for supposing that they have not been carefully considered, or that they will not be realised in practice.

Proceeding with our review of Mr. Spooner's book, we next find comparative plans, showing how an ordinary 4 ft. 8½ in. gauge line and a 2 ft. 6 in. gauge line, worked with bogie rolling stock, could be laid down through a certain track of country, these plans being accompanied by notes of the advantages gained in the latter case. Next we have reprints of two letters "On Railway Gauges," addressed to this journal in November, 1870, together with one of our articles in reply, and these are followed by reprints from *The Engineer* of articles on "The Battle of the Gauges," and "Indian Railway Gauges and Rolling Stock," which appeared in that journal in November and December, 1870. Many of the fallacious arguments advanced in these latter articles were exposed by us at the time of their publication, and we need not, therefore, speak of them here.

Next we have Mr. Spooner's own remarks on the subject of the Indian narrow gauge railways, in the course of which he points out the objections to making light railways of the ordinary gauge. In connexion with this subject he says: "It has been proved by experience on the Festiniog Railway that a rail of 30 lb. to the yard will not bear the weight of a locomotive of 2½ tons on each wheel, even with sleepers having bearings of 2 ft. 6 in., and 1 ft. 6 in. at the joints, and the 48½ lb. rails now used are not at all too strong. There is no doubt that for a weight of 3 tons per wheel, a rail of not less than 55 lb. per yard should be used, and for 4 tons per wheel, the rail should weigh at least 65 lb. per yard to insure stability and fair wear and economy of maintenance of way." Mr. Spooner also supplements his remarks by giving dimensions and particulars of stock he would recommend for Indian narrow gauge lines, and he concludes by giving some further particulars of the wagon stock on the Festiniog Railway, together with a comparative table of the capital, receipts, expenditure, &c., of a number of home and colonial lines.

We have now concluded our survey of Mr.

* [In accordance with the request expressed to us by numerous correspondents, we intend in future to affix to the titles of any books reviewed the prices at which the works are published, in all cases where such prices are known to us.—ED. E.]

Spooner's book, and we have, we think, pointed out fairly its merits and defects. We cannot agree with all Mr. Spooner's figures, and we regret that his work, instead of being devoted entirely to his own views, should have been burdened by numerous reprints which we consider would have been better omitted; but the book is nevertheless one containing a great deal of information which will be useful to those interested in narrow gauge railways, and as such it is well worthy of notice.

MECHANICAL REFINEMENTS.—No. XI.

To the Editor of Engineering.

Sir,—Bearing in mind the fact that no amount of science and theory can produce a creditable engine, machine, or tool, without the aid of a skilful workman; and that no amount of work, however good, can make a successful structure unless skilfully applied, it would seem that the theorist and workman are more or less dependent upon each other, that each should be entitled to his share of credit, and that whatever can be done to harmonise the two in feeling as well as in work will tend to advance the progress of both.

While it is not uncommon to hear workmen, and good workmen too, sneer at the fine-spun theories of an engineer, it is quite as common to see engineers who claim all the glory of some success leaving the workmen—without whose aid the work might have been a failure—entirely unacknowledged. This is plainly not only unfair but impolitic, for he who is dependent upon another for success should court his aid, and thus ignoring one's merits, either privately or publicly, is just the way "how not to do it." If the theorist who thinks that doing the work is a matter of little consequence, will take hold with his own hands and try it, he will not only have a better opinion of a workman, but will be better able to test and teach his own theories, and better able to judge of the time and cost of work and the readiest way of doing it.

As an illustration of the reluctance with which workmen and people in general accept indisputably correct principles when they are at variance with common practice, the experience of an architectural acquaintance who has more talent than reputation is a good one. He says, "Of the thousand architects, builders, and workmen, to whom I have explained and convinced that the true theory of building foundations consists in having the centre of the foundation exactly under the centre of the weight sustained, and every part of the foundation of a width proportionate to the load, but one ever adopted it wholly, and he is dead." Many engineers have had similar experience, and if there is a tendency growing in the direction of a more ready acceptance of new ideas by workmen it is lamentably slow and will hardly be improved by any number of school graduates styling themselves "machine feeders" or other like appellations.

As this may possibly be looked upon as a sort of imaginary condition, let those who think so convince themselves that the following is the correct method of securing work to planer beds or lathe face plates, and see how many fitters or machinists they can get to adopt it.

To plane a piece of cast iron perfectly true on a true plane is a job not often accomplished by the best workman, and for two reasons, first, the casting is liable to be sprung in securing to the plane bed, and in the usual way no hand is so delicate as to avoid it altogether. Secondly, removing the scale from one side, by relieving the strain, gives it a tendency to warp, so that when the casting is loosened up it is out of true. These facts are well understood and partially avoided by "shimming" up the work directly under the straps as carefully as possible to neutralise the first trouble, and loosening up the straps to the lowest tension so as to confine the work the least possible for the second. These are at the best but modified remedies, but resting the work of whatever shape or character on three points or bearing places and securing it by three clamps directly over the bearing points overcomes both difficulties perfectly. This principle is subject to so broad an application that I can hardly conceive of a shape of any material, unless it be too delicate to withstand the pressure of the cut, for which this triangular support is not the correct one, even if the casting is of such a size as to appear to be beyond the possibility of springing—very few planer beds are, and it is as bad to spring one as the other: the three support system will spring neither. Apply the same principle to securing work to the face plate of a lathe. Take for example a six-arm pulley, block out the pulley from the face plate by using only three packing pieces under the alternate arms, and secure it by three straps directly over the packing pieces; it may then be bored, faced, and at least rough turned if not finished without the least fear of its changing form when taken off. In answer to the question, "Supposing the pulley had but four arms?" even then it is best to use but three supports, leaving the fourth arm free.

Nothing will tend more to induce workmen to adopt new ideas than to encourage them in their own, and nothing tends more to stimulate their ingenuity than giving full consideration, and—if not too unreasonable—encouragement to the subject of their contrivances.

Engineers are sure to be consulted more or less on the practicability of schemers' contrivances, and sooner or later on some of the perpetual motion class. It is usual in such cases to turn off the deluded individual with a sneer, but a brief consideration of the subject will show that that is not the best nor the right thing to do. He who has not the ability to dissect and analyse an invention and point out the fallacy has no right to say there is one. To say a certain device will not answer because not in accordance with the laws of mechanics is no reason, and when counsel cannot make the client understand why his device will not work it may be because he really does not know, or has not the ability to make himself understood, rather than stupidity on the part of the client.

This letter was commenced with a view to introduce illustrations of a number of new mechanical appliances, wherein workmen have turned the theoretical ideas of others to practical account. In order to give the originators the greatest benefit, still excluding personality—as I have endeavoured to do from the first—it seemed necessary to present them with an introduction, and that has called out the foregoing thoughts (some of which I believe are worthy of a more extended consideration) to the exclusion of the original subjects, which latter I leave for another time.

I am, yours truly,
An English Engineer in America.

RANDOM NOTES FROM NORTHERN INDIA.

N.W. Provinces, October, 1871.

With the advent of the cold weather, down rush from the hilltops all the ruling powers—chief and superintending engineers go on their tours of inspection, executive and assistant engineers are all on the alert, tents are pitched, instruments are adjusted, camps, with the usual accompaniment of elephants, camels, bullocks, &c, are collected, new projects have to be surveyed, old ones revised and remodelled; all is energy, and life, stir, and bustle are the order of the day. We are now sanguine that something practical will come of our work (for engineers always hope so when they fully enter into the spirit of it), but will this hopefulness survive the long period of reporting and re-reporting, and the prolonged deliberation, which may extend over years, before the result of our labours may either be the sanctioning of a project, or the interment in a pigeon-hole "for record" of all the plans, with their attendant numerous reports and memos? This has been the experience of the past, but let us hope for a better state of things in the future, for surely the day cannot be far distant when the long promised substitution of "action for writing" will become a reality.

There is at present every appearance of a serious intention to push on the State railways, as there is great activity in that department. That portion of the Indore Railway between Indore and Khundwah (85 miles), is about to be started at once, and tenders have for some time been invited for the construction of a part of the Delhi and Rajpootana State Railway. The people of Darjeeling have just petitioned Government to allot them land for a light mountain railway, which, if carried out, will be the first line of the kind in India. They might, with advantage, study the Riga line, the principle of which appears to be very suitable for the Himalayan mountains.

The Punjab Canal Bill has at length emerged from the hands of the committee, to whom it was consigned many months ago. The main principles of this Bill—which will, no doubt, when passed by Government, tend to largely develop irrigation, and lead to the extension of new canals in the Punjab—were laid down by the late Inspector-General of Irrigation (Colonel Strachey). They are, first, compensation by Government for water cut off by new canals, which had previously been used by the people for irrigation purposes, mills, &c., and, secondly, authority to levy compulsory rates on all lands irrigable from Government canals, whether the proprietors and occupiers use the water or not. Such a law has long been in contemplation, and if passed, it will doubtless soon be followed by similar enactments for the N.W. Provinces, Oude, and other parts of India.

To the English ear such an arrangement sounds harsh and arbitrary, but India loudly calls for water, and public opinion and common sense say supply it; but these canals cannot be constructed without large amounts of money, and the Government, before committing itself to such undertakings, must have the certainty of a legitimate return on the outlay. In a word, the lazy and unenterprising few cannot be allowed to stand in the way of the great majority who call for water, and vast districts of country must not be consigned to periodical famines (the horrors of which must be seen to be appreciated) through consideration for those who will hang behind, and refuse to progress with the times. This compulsion is more on the surface than otherwise, or apparent than real, as, when the water is brought to hand, and the evidence of its fertilising power becomes apparent by the crops produced, those who at first hung back are often the most anxious to secure it.

It is proposed not to enforce the compulsory rates until a new canal shall have been open five years, when, if idleness or stupidity still stand in the way, the Government will step in, and put on the pressure of its authority.

The guardian angel of the Public Works Department seems to have again deserted it in Allahabad, for the new barracks in that station have been declared unsafe, and on the recommendation of the superintending engineer, the troops have vacated these buildings, and are now under canvas, while a minute inspection of the barracks is being made.

It appears that Lord Mayo has appointed a committee to meet at Sangor in December to report finally on the failure of the "palatial" barracks in that place, and all the officers who were engaged on the work have been summoned to attend

The Nizam's State Railway to Hyderabad is to be at once recommenced as a narrow-gauge line, and the *Madras Mail* calls on the new superintending engineer to acknowledge the merits of Mr. Reynolds, C.E. (one of the experienced civil engineers who came to India in 1868), as it appears that thanks and praise from the Government were given to some members of the Corps of Royal Engineers for the work which had in reality been done, on the above railway, by Mr. Reynolds, who is an engineer of much railway experience. It is to be hoped that this hint may be attended to, for, if the truth must be told, an impression prevails that some of these comparatively newly imported civil engineers are expected rather to work the strings for others than to figure on the stage themselves.

The new Principal of Roorkee College has resumed the publication of the Roorkee Engineering Treatise, which was discontinued when Colonel Medley left. The former gentleman availed himself of the formal closing of the Session to extol the engineers whom that college annually turned out, and stated that they were quite equal to the civil engineers sent out by the Secretary of State, a statement that would be very satisfactory if it could be thoroughly relied on, for if qualified and competent engineers can be turned out of a college in India, or on the spot, in two years, we do not surely require Cooper's Hill College, nor is there any necessity to further come on the home profession for supplies.

Some people out here, who do not quite agree with the views expressed by the gentleman referred to, are of opinion that, if Cooper's Hill College will supply the superior article that we here expect and look for, our Indian engineering colleges must, in time, fall into the shade. Some of the Indian papers commented severely on what they termed the invidious comparisons made by Captain Lang, and see in them a blow at the profession at home, and the spirit of the "obnoxious notification" once more making its appearance.

THE DIAGRAMMAGRAPHE.

M. Pichault, of the establishment of the Société John Cockerill, at Seraing, has recently contributed to our contemporary the *Annales Industrielles*, an account of an ingenious apparatus contrived by him, and which is now in use at Seraing, for ascertaining the characteristics of different systems of valve motions. As the apparatus is one which will no doubt interest a large number of our readers, we propose availing ourselves of M. Pichault's memoire, to give an account of it here.

The apparatus, then, to which M. Pichault has given the name of "Diagrammagraphe," is intended to trace automatically a curve representing the exact conditions of the whole distribution of steam effected, by one or two slide valves, driven by one or two eccentrics, and actuated either direct or through the intervention of any system of valve gear. The principle upon which the contrivance is constructed is very simple, and will be readily understood by considering the following imaginary case. Let us suppose an engine of any ordinary construction, furnished with a single slide valve actuated by a movable link—a locomotive, for example—to have placed on the end of the driving axle a disc covered by a well-stretched sheet of paper, and let us further suppose that in front of and parallel to the face of this disc there is a guide bar, this guide being situated in the plane passing through the axis of the piston rod and valve spindle. Thus, if the cylinder and valve spindle are horizontal, as we shall suppose in the present case, the guide bar will be horizontal also. Further, let there be fitted to the guide bar a sliding piece carrying a tracing point bearing against the paper on the disc, and let this sliding piece be so coupled to the valve spindle that it has a motion exactly corresponding to that of the slide valve. If now the driving axle be caused to revolve, it is evident that the tracing point will describe on the paper a certain complete curve, the polar co-ordinates of which will represent exactly the motion of the slide valve. Thus, the tracing point will, at each

change in the position of the crank, approach or retire from the centre of the disc by a quantity exactly equal to the movement of the slide valve itself. A curve having been obtained in this way, let the slide valve be next detached from its driving gear, and placed in the position it would occupy when it had just closed one of the ports; for instance, that leading to the front of the cylinder; and this being done let the driving axle be caused to perform another revolution. Under these circumstances the valve, and consequently the tracing point being stationary, the latter will describe a circle on the disc, and the points at which this circle cuts the curve formerly drawn, will evidently be the points at which the front steam port was either just closed or just on the point of being uncovered by the valve. If, then, radial lines be drawn from the centre of the disc through these points of intersection, these lines will represent the positions of the crank at which the events just mentioned took place.

In like manner by refixing the valve in other positions, and repeating the operation above described, all the other chief events of the distribution can be determined with accuracy for both strokes of the piston. To complete the diagram it is necessary to draw a radial line, called by M. Pichault a *rayon origine*, corresponding to the crank, and this can be done by placing the crank on one of the dead points and simply moving the tracing points along its guide. It is also convenient to fix the valve in the position which it actually occupies when the crank is on the dead point, and to describe a circle with the pointer in the position thus given to it. If the circle denoting the middle of the stroke of the valve be drawn and the centre of the disc marked (by drawing with the tracing point a line intersecting that already delineated when the crank was on a dead point), the paper can be removed from the disc if desired, and the other circles required to mark the points of admission, suppression, exhaust, and compression drawn upon it subsequently. These latter circles will be situated inside and outside what we will call the datum circle, and distant from it by the amounts of the outside and inside laps of the valve respectively.

FIG. 5.

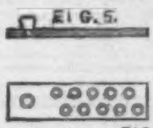


FIG. 6.

FIG. 7.

FIG. 9.

FIG. 12.

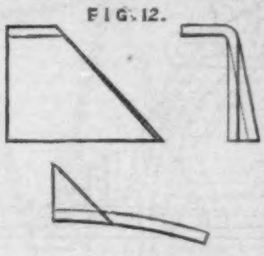


FIG. 11.

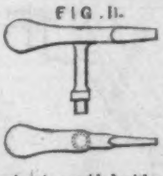
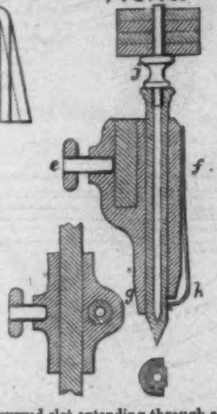


FIG. 13.



The above-described operations being performed, it is evident that we have obtained a diagram giving complete information concerning the movement of the valve, and it only remains to add certain lines which will assist in reading off the results. For this purpose let the diameter drawn by the tracing point—when the crank was on one of the dead points—be divided into any convenient number of parts, and let there be drawn through each of the points of division an arc of a circle described with a radius, which is the same multiple of the diameter of the datum circle that the length of the connecting rod is of the stroke of the piston; the centres from which the arcs are described, moreover, being situated on a prolongation of the above-mentioned diameter towards the side (with respect to the centre), on which the tracing point is situated when the crank is directed towards the cylinder.

Having explained the principle upon which the "diagram-magraphe" is based, we may now proceed to describe the apparatus itself, referring for that purpose to the engravings on page 386. Figs. 14 and 15 of these illustrations show respectively a general elevation and plan of the apparatus as applied to the investigation of the action of valve motion of the ordinary shifting-link kind, while Figs. 1, 2, and 3 show, to a scale of one-fifth full size the chief details of the mechanism. Upon a large and solidly-made wooden-table is bolted a cast-iron base, *a a*, mounted on three feet, and covering a circular opening cut in the table. This base is, properly speaking, a kind of large eccentric strap having an internal collar at its lower edge, as shown in the section Fig. 1. The axis of this eccentric strap is taken as representing the centre of the driving axle, and within this strap there are placed two eccentric sheaves, *c* and *c'*, fitted so as to move with but little friction, and kept in position simply by their weight resting on the internal collar of the strap already mentioned. Each sheave has formed in it a radial slot, in which a pin (*c c'*) can be adjusted, and each of these pins, which represents the centre of one of the eccentrics of the valve gear under investigation, is fixed by means of a nut as shown, at a distance from the centre of the axis equal to the radius of the eccentric chosen for examination. This distance is measured by means of scales of millimetres engraved on the sides of the slots, and diametrical index lines marked on the pins.

To the lower eccentric pin, *c*, is attached a rod, *t*, coupled to the wooden rod, T, in such a manner as to form an eccentric rod of adjustable length. In a similar manner the pin, *c'*, of the upper eccentric is attached to the rods, *t'* T', each of the rods, T and T', being provided at its end with one of the metal joint pieces shown by Figs. 8 and 9, these joint pieces being six in number. By means of these joint pieces the two eccentric rods are coupled to the expansion link. Each of the rods, *t*, *t'*, has marked upon it, at a known distance from the centre of the eccentric pin (0.3 metre in the case of the particular apparatus we are discussing), a line, by the aid of which the length of the eccentrics can be adjusted without its being necessary to dismount them.

The pin, *c'*, of the upper eccentric is much larger than that of the lower eccentric, and it is also more perfectly guided in the slot in which it moves. The reason for this is, that it is employed to rotate a large cast-iron plate, *l*, which covers the whole of this part of the apparatus, and on the under-side of which there is formed a diametrical groove as shown. To this groove is fitted a sliding piece having at one end an eye which fits the pin of the upper eccentric, and, as will be seen from Figs. 1 and 2, the arrangement is thus such that the eccentric can communicate its rotary movement to the plate, *l*, notwithstanding that changes may be made in its eccentricity. The upper side of the plate, *l*, is perfectly faced, and the plate is, moreover, carefully fitted into the annular casting or collar which forms a bearing in which it can revolve and which is provided with a ledge or rebate on which it rests.

The upper edge of the collar, or annular casting just mentioned, is divided out into degrees and half-degrees (the half-degrees are not shown in Fig. 3), and the upper side of the plate, *l*, is marked with a diametrical line which corresponds to the centre line of the radial slot in the upper eccentric. If now the lower eccentric be placed with the centre line of its throw corresponding to the zero point in the circumferential scale just referred to—and the collar, *s*, is provided with a set screw for fixing it in that position—it is evident that by means of the diametrical line on the plate, *l*, and the circumferential scale, the two eccentrics can be set at any desired angle to each other. The central parts of the two eccentric sheaves are so formed—as will be seen by Fig. 2—that they fit into each other; while the lower one also is provided with a curved slot extending through an angle of 180°. In the upper sheave are two holes, V, V', and into one or the other of these holes (according to the relative positions of the two eccentric sheaves) can be screwed a bolt by means of which the two sheaves are clamped together after their centre lines have been adjusted to the proper angle. A small curved index plate, shown by Fig. 12, enables the upper eccentric to be set to any desired angle denoted by the circumferential scale, when the top plate, *l*, is not in place.

The lower eccentric, *c*, is provided on its under side with bevel teeth which gear into the bevel pinion, *p*, and by this means it receives the movement of a horizontal axis provided with the handle, *m*. The shaft on which this handle is placed is prolonged a convenient distance so that the handle is clear of the wooden table near one of the corners of which the whole apparatus is placed. Just above the bevel pinion there is placed, to resist the upward thrust of the latter, a small roller which bears upon the upper eccentric, and which is so mounted (as shown in Fig. 2,), that it is very easily removed and replaced.

The whole of the parts of the apparatus are very carefully fitted together, and it will be seen that by means of the handle, *m*, the eccentrics can be made to revolve steadily and by small distances at a time if necessary. The plate, *l*, is for the purpose of receiving the paper on which the diagram is to be drawn, and to enable the paper to be readily fixed to this plate there are formed in the latter a number of cavities filled in with soft wood into which drawing pins can be inserted.

The plate, *l*, is also provided at the centre with a tapped hole into which there can be screwed the handle shown by Fig. 11 (one arm of this handle being available also as a screwdriver) for the purpose of lifting the plate when access is required to the eccentric sheaves. The plate, *l*, has also formed in it near its circumference (see Fig. 3) a curved slot extending through an arc of 60°. When a diagram is being taken this slot is filled by a perfectly fitting piece of metal; but if at any time it is desired to give motion to a part representing a piston, this slot serves to receive a pin, *r*, which by means of a wooden connecting rod, with end fittings of metal, can be coupled to the sliding piece by which the piston is represented. This, however, is an exceptional case. In taking diagrams with the apparatus we are describing there is no necessity for employing a crank pin, a radial line on the paper serving every purpose, save, however, being of course taken that this radial line stands in the proper position with regard to the eccentrics. It will be seen from what we have just stated, that, ordinarily, the crank pin, *r*, is not used with the diagrammagraphe, but the piece is turned to account in shaping the link as we shall proceed to explain.

The expansion link is of a different form in almost every valve motion which has to be investigated; but it is in all cases an arc of a circle of a certain length and certain radius, and in an apparatus of the kind we are describing it is particularly desirable that it should be possible to produce a link of any desired radius with ease and exactness. The plan adopted by M. Pichault for this purpose is very ingenious and is as follows:—The eccentric rods, T, T', are jointed (as will be seen from Figs. 14 and 15), the one above the other below, to a wooden plate, *p*, which is perfectly rectangular, and which simply rests and slides upon the wooden table already mentioned, being supported on a couple of ledges or feet, on its under side which serve to keep it from bearing upon the lower eccentric rod. Upon the upper side of the plate, *p*, is fixed by screws a piece of thin wood or veneer, *m*—a wood without much grain, such, for instance, as the lime, being preferred—and in this thin veneer is cut the slot which represents the link and to which the sliding block is fitted.

To cut the slot correctly in the veneer, *m*, the plate, *p*, is securely fixed (by means of a couple of bolts not shown in the engraving) to the wooden table, and the veneer is then secured in its place. On the plate, *p*, at the middle of its length there is drawn a line perpendicular to the length of the plate, and on a prolongation of this line at a distance from the middle of the plate about equal to the radius of the desired link, is placed the pin, *r*, which we have mentioned as serving on occasion the purpose of a crank pin. To enable the pin, *r*, to be adjusted properly to a prolongation of the line on the plate, *p*, it is mounted on a piece of wood of convenient thickness, which is shaped so that it can be adjusted accurately to the edge of the plate, *p*. This piece of wood when adjusted can be secured to the table by means of a screw. A centre being thus obtained, there is attached to a radius rod working on this centre the plane shown, by Fig. 4 on page 386. This plane has two blades as shown and it is traversed by a hole through which the radius rod passes, the arrangement being such that the plane can be adjusted to cut a curve of any desired radius. By means of this contrivance the groove or slot representing the slot in the expansion link can be readily and accurately cut in the piece of wood, *m*, fixed to the table, *p*, as already mentioned. The block working in the link is also made of wood and accurately fitted, and it is provided with the centre pin or pivot shown in Fig. 7 on the present page. It may be observed here that this centre and also the joint pieces Figs. 8 and 9, to which reference has already been made, are furnished with central points on the under side, which enable them to be accurately adjusted to their positions.

The joint piece for uniting the upper eccentric rod to the table, *p*, is shown by Fig. 9 on the present page, while Fig. 8, on page 386, shows the junction piece which serves for the lower eccentric rod and lifting link. The pins of these joint pieces are simply screwed to the table, *p*, as shown. All the pins are of the same diameter, so that facilities are afforded for building up motions of different classes.

The valve rod, which is of wood, is of a convenient length, and is united to the block of the link by the joint piece shown in Fig. 6 on the present page, and to the valve by a piece shown in Fig. 5 or by one similar to Figs. 8 and 9. In the general arrangement represented by Figs. 14 and 15, the valve rod is shown guided by a link oscillating on a fixed point, *f*, but in many instances this link is not required and the valve rod is merely guided rectilineally by a simple wooden guide.

Referring again to Fig. 15, on page 386, it will be seen that the expansion link is connected by the suspension link to the lever, *l*, pivoted on a fixed point, F, which represents the weigh shaft. It is often desirable when the action of a valve motion is being investigated, that the position of the shaft just mentioned should be capable of being readily altered after the various parts composing the gear have been put together, and in the apparatus under consideration this can readily be done.

The slide valve, *q*, is composed of a piece of thin wood fitted accurately between a pair of guides, *k k'*, the centre line of the space between these guides passing, when prolonged, through the centre of the driving axle. Two slips of paper are fixed, by means of spring clips, on the slide valve and one of the guides, *i*, respectively, there being drawn on one of these strips a section of the slide valve, and on the other a section of the cylinder ports. If a motion with double valves is being investigated, then two pieces of wood, representing these two valves, are fitted between the guides, *k k'*.

Returning now to Figs. 1, 2, and 3, it will be seen that the annular casting, *s*, which forms the support for the eccentric sheaves and for the disc on which the diagram is drawn, is furnished with two brackets, *g*, which are bolted to it as shown and which serve as guides for the steel bar, *i*, upon which there is mounted the tracing point shown to an enlarged scale by Fig. 13 on the present page. The bar, *i*, is connected to the slide valve by a wooden rod as shown in Figs. 14 and 15, and thus the tracing point attached to it follows exactly the motion of the valve.

The tracing point itself (see Fig. 13) consists of a small brass cylinder which terminates in a conical point, and which moves with a slight friction in a socket which is fixed in any desired position on the steel rod, *i*, by a set screw. The brass cylinder is hollow and the cavity in it communicates with the points of the cone by a fine capillary hole. The cavity being charged with a solution of Indian ink or other suitable colour, the point acts as a drawing pen, the proper pressure on the paper being given by loading it with small discs as shown, while a spring, *h*, serves to keep it steady.

We have now described the general construction of M. Pichault's apparatus, and we need scarcely add that the arrangement is one which gives great facilities for testing different varieties of valve gear. It remains for us to explain the best mode of using the apparatus for the purpose of investigation, and this we shall do in a subsequent article.

(*To be continued.*)

"DIAGRAMMAGRAPHE" FOR INVESTIGATING THE ACTION OF VALVE GEARS.

DESIGNED BY M. S. PICHAULT, ENGINEER, SERAING, BELGIUM.

(*For Description, see Page* 384.)

FIG. 1.

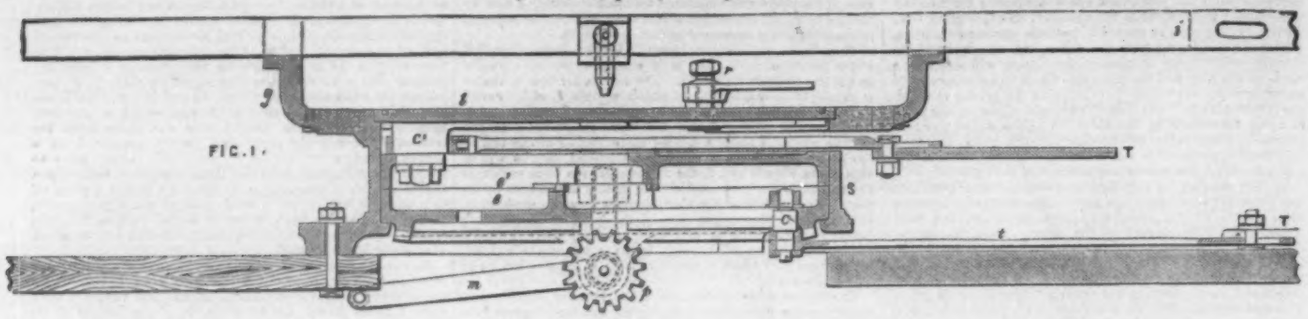


FIG. 2.

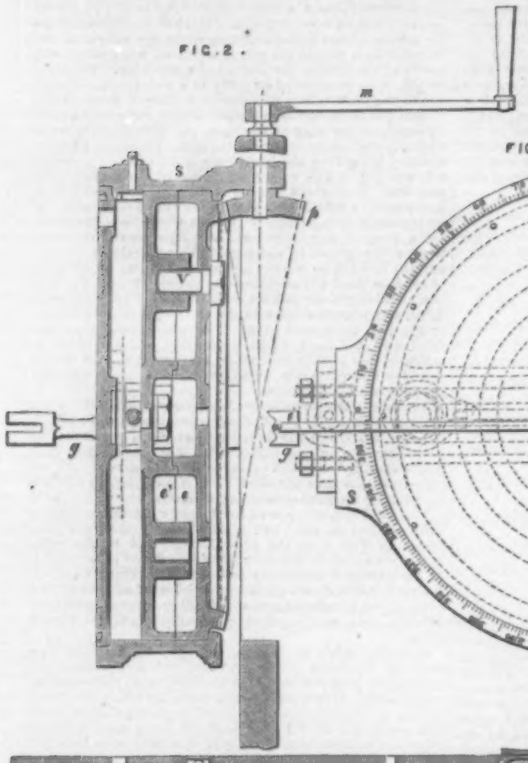


FIG. 3.

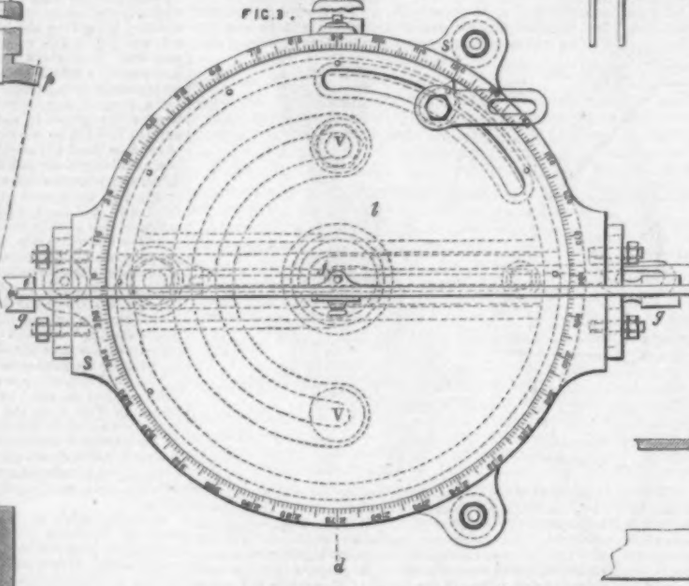


FIG. 4.

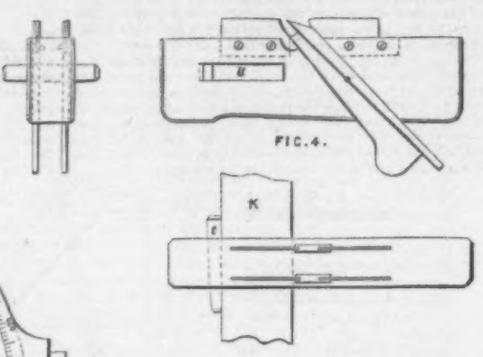


FIG. 8.

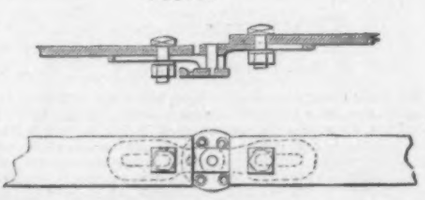


FIG. 14

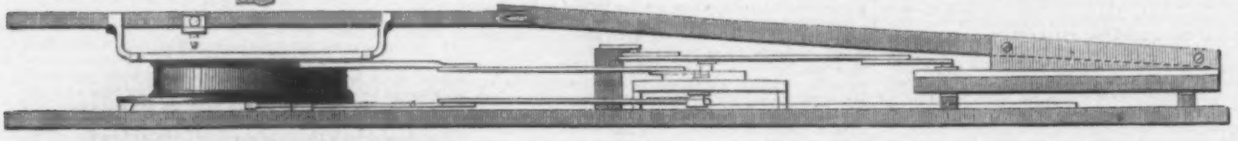


FIG. 10.

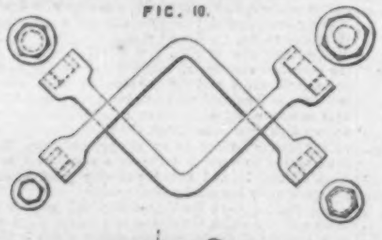
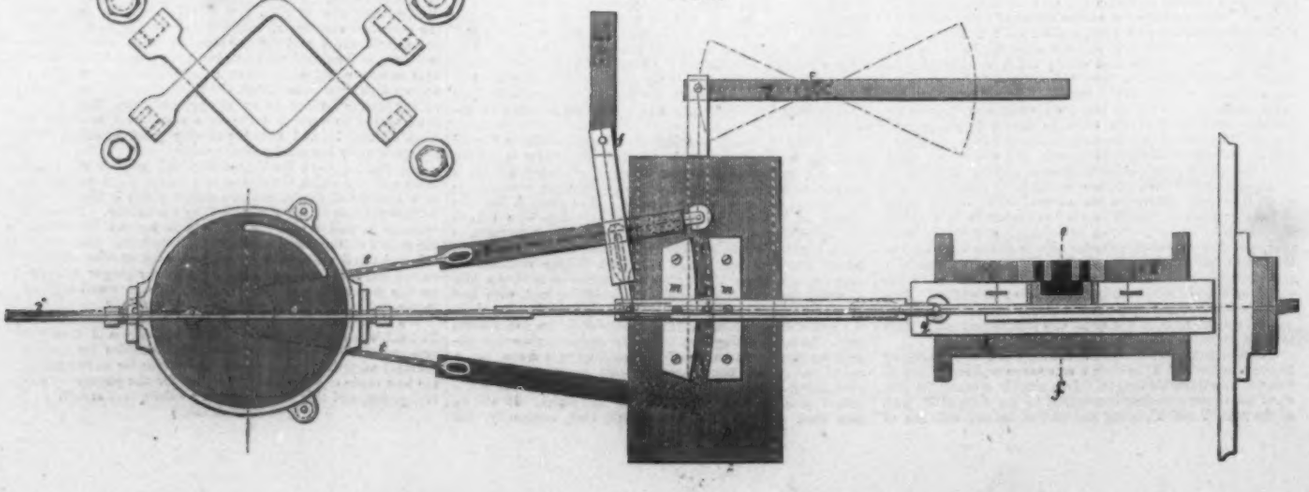


FIG. 15.



ROOF AT THE GOODS STATION; BERLIN-POTSDAM-MAGDEBURG RAILWAY, BERLIN.

HERR F. WOHLERT, ENGINEER, BERLIN.

(*For Description, see Page* 388.)

FIG. 6.

FIG. 1.

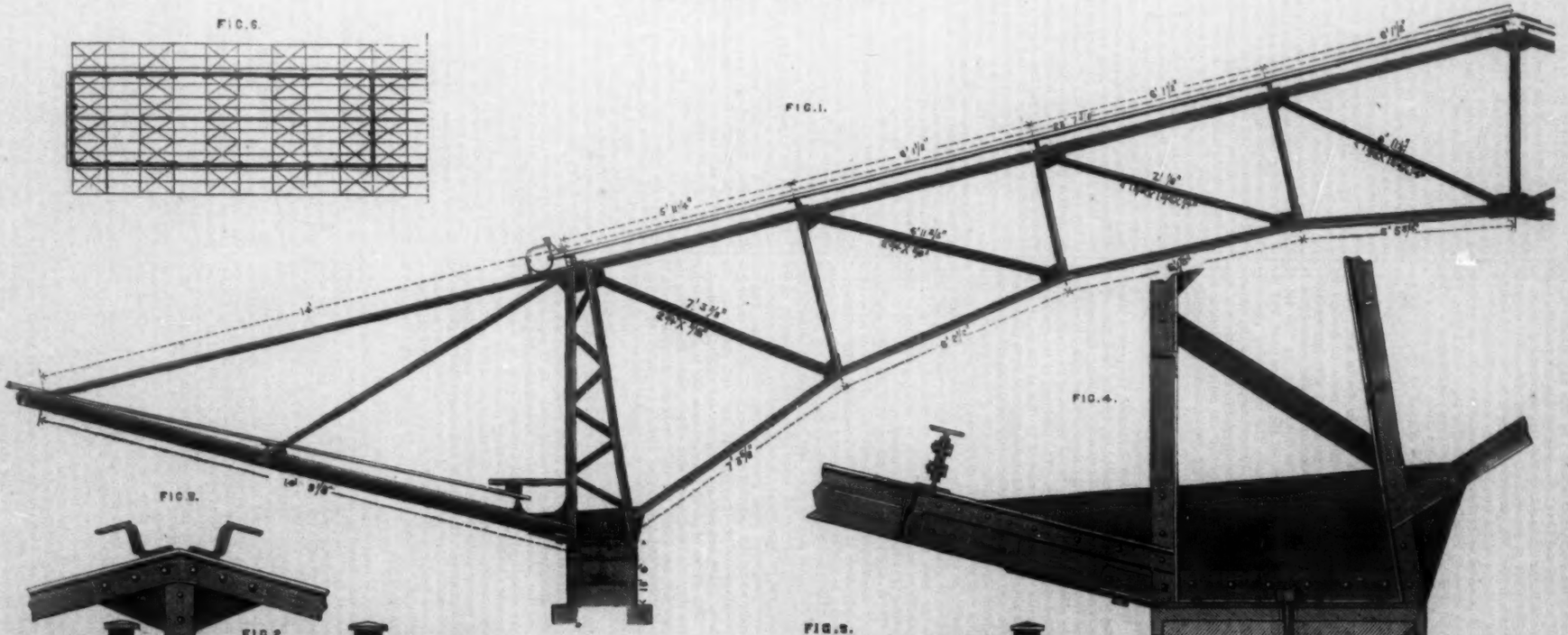


FIG. 4.

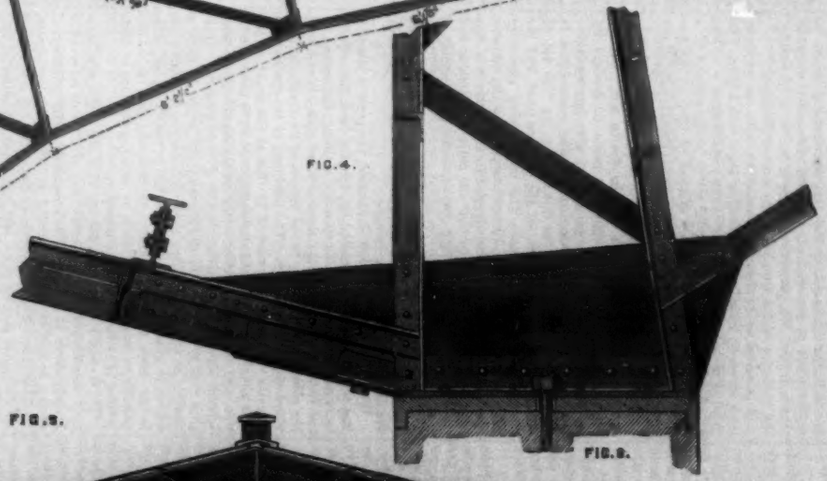


FIG. 3.

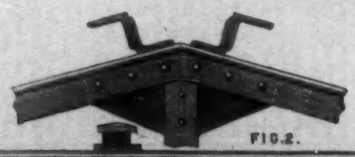


FIG. 2.

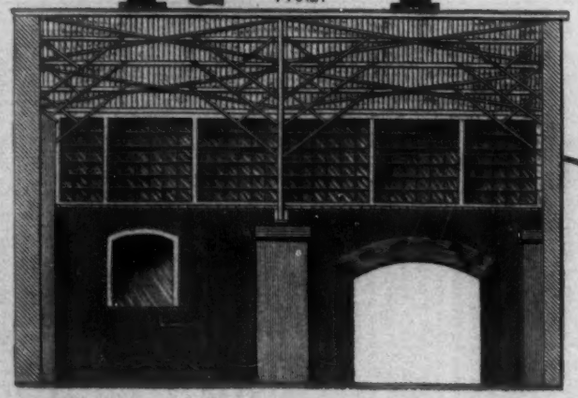
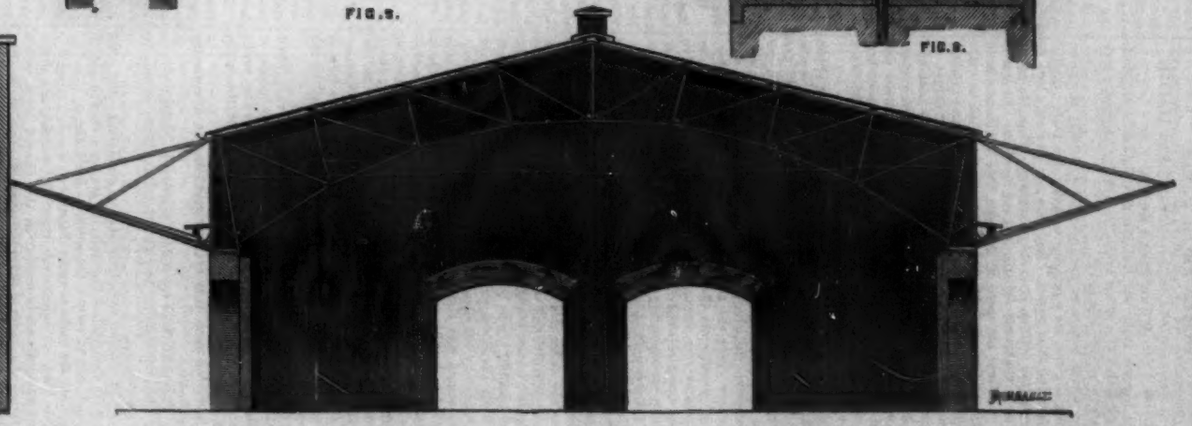


FIG. 5.



NOTES FROM PARIS.

Paris, Dec. 11, 1871.

A New Steam Brake.

We borrow from the *Bulletin de l'Industrie Minérale* the description of a steam brake for winding engines, which appears to be very successful.

The steam brakes at present most generally in use on winding engines, are especially valuable for their rapidity of action and their power. But this rapidity may lead to ruptures, and besides, it is only necessary, when the brake acts as an apparatus for stopping the machine. If it acts only to reduce the speed of the rope, this suddenness is no longer required, and, on the other hand, it would be valuable to obtain from the brake a less sharp and more gradual action. Now the steam brakes can hardly work except to the maximum of their power. They give all or nothing; they are stopping brakes, and not adapted for manœuvring. It is upon this base that an apparatus, designed under the name of the Variable Action Steam Brake, has been worked out, and made in the shops at Commentry, and since adopted at several large mines.

The brake cylinder, instead of having, as usual, an upper cover, communicates by the whole of its area with a steam chamber, of which the capacity is about threefold the volume of the cylinder. This chamber connects with the valve chest, the table of which has three openings; the lowest serves to admit the steam below the piston, the upper one opens the steam into the cylindrical chamber, and, of course, upon the upper face of the piston, and the intermediate one serves as the exhaust. The slide valve has its upper side enlarged, and pierced with a rectangular opening, corresponding to the highest opening in the table. The valve is worked by a man from a lever.

When the brake is not in operation, the valve uncovers the highest and lowest openings, so that the steam acts equally on both sides of the piston. If the valve is moved, the lowest opening remains free, and the steam continues to act on the under side of the piston, but the upper opening closes gradually, and soon the steam contained in the upper chamber becomes confined. If the valve is again varied, the upper opening begins to communicate with the exhaust, and gradually the steam escapes. This movement is rendered progressive by the special form given to the upper opening. By reason of this slow escape, the piston forced upwards from below by the steam is moved slowly, and the brake is gradually put in action. Is it desired to hurry this movement? The upper opening is uncovered, and the steam in the chamber passes out. If, however, the contrary effect is desired after releasing from the chamber a part of the steam, the valve is lowered to cover the upper opening. The steam in the chamber is thus confined, with a portion of its initial pressure, and limits the efforts produced on the piston rods.

If this effort is too strong or too weak, the valve is raised or lowered either to admit into the chamber more steam, or to allow more to escape. A gauge placed before the workman, allows him to regulate the movements of the brake with the utmost nicety.

The brakes upon this system established at Commentry have shown:

1. That with them too sudden starting is avoided.
2. That the starting may be effected as slowly as may be wished.
3. That one can vary from zero to maximum—and that with the greatest facility—the pressure on the piston rod, and, of course, the power of the brake.
4. That the brake is easily handled.

This kind of brake seems especially suitable for shafts where materials are lowered from the ground level, either for lining the shafts or other purposes, because it is often difficult with the ordinary brakes to easily adjust the rate of descent.

Tin Lined Lead Pipes.

On page 314 of the sixth volume of Engineering, we alluded to a process introduced into France by a M. Hamon, of Nantes, for the manufacture of tin lined lead pipes. This process, which is very similar to the one long in use in America, has been made recently the subject of a report by M. Tresca to the Société d'Encouragement, in which he refers to the manufacture and the properties of these pipes.

The details of manufacture are very curious and require a special plant, as much for the casting of the ingots as for the fabrication of the pipes. The casting of the ingot is made in a metal mould, in which a large tube of lead is first cast, and then inside this tube a second one of tin. In the centre of the mould is placed a mandril of the same diameter as the lead tube, extended on the lower side by a smaller mandril of the inner diameter of the tin tube. After casting the lead, which enters the annular space from below, it is left to solidify, then by the assistance of an hydraulic press, which is used in conjunction with an accumulator, the mandril is gradually raised. Then the tin is poured through an opening made in the mandril itself, and thus is filled the annular space corresponding to the difference in the diameter of the large and small mandrils.

In order that the tin may attach itself thoroughly to the lead, it is necessary that the surface should be always fresh, and not oxidised. To achieve this the mandril is furnished at the point corresponding to the change of diameter with an annular tool, which scrapes the inner face of the lead at the moment that the tin is cast on it. This practical arrangement works well, and assures the formation of a thin bed of alloy interposed between them, and which resists subsequent mechanical action. In this way tubular ingots 15¾ in. high and 7¾ in. diameter outside are produced, and in which the thickness of the tin is calculated so as to reduce itself to the desired ultimate dimensions when the pipe is drawn. The perfect centering of the tin is assured by the guidance of the mandril in the axis of the ingot.

A powerful hydraulic press connected with an accumulator serves to transform this hollow ingot into a pipe. The ingot is placed on the plunger of the press around a cylindrical rod. This rod is extended above in the interior of a cylinder, the diameter of which is equal to that of the exterior of the ingot attached to the fixed cross-framing of the press.

The cylindrical rod finishes above in a reduced diameter equal at the end to the bore of tube drawn out. On the fixed frame a movable framing is made to descend by the aid of a small hydraulic press, and this surrounds the reduced end of the rod, leaving an annular space equal to the thickness of the pipe. In this manner, by the aid of adjusting screws, dimensions of the pipe are fixed, and the main press is put into action. The ingot rising gradually along the cylindrical rod, becomes engaged in the annular space between itself and the adjusted framing, and it is thus forced to extend itself in the one desired direction, and rises in the form of a pipe, to be wound off on spools as it is gradually forced out.

The fixed frame which the ingot passes immediately before being drawn, is heated to a temperature of 248° Fahr., by the directed flame from a furnace.

When the ingot is almost exhausted, the press is stopped, and the apparatus dismounted by running back the adjusting screws, and raising the movable framing by means of the second auxiliary press; about 3 ft. of piping is lost, and the plunger drawn down to the bottom of its stroke, is provided with a fresh charge. The thickness of the drawn pipe remains very well proportioned to that of the ingot, as the two metals are drawn simultaneously under the same condition, and each unit of cross section of the ingot is thus transformed into a corresponding length of finished tube. It is then easy to regulate the thickness of the ingot in such a manner as to obtain in the pipe the relative thickness required in practice. The tin adheres perfectly to the lead. It has been shown by many experiments that it is impossible to separate them, even by bending the pipe or subjecting it to the blows of a hammer.

M. Hamon took out his patents in 1867. His manufactory, established first at Nantes, was afterwards removed to Paris, where it was greatly extended. The quantity of piping he sold in 1869 amounted to 300,000 kilogrammes. Architects and house proprietors have largely adopted the tin lining for service pipes, and it is generally admitted that this lining removes all danger from the dissolution of the lead, and its consequent sanitary dangers. The soldering of these compound pipes presents some difficulties. The tin melts whilst the soldering iron is applied, offering the double inconvenience of denuding the lead, and obstructing the bore. Skill and care are necessary for avoiding these evils.

The fitting of cocks also presents the same difficulties, but they can be attached with sockets, since hammering the pipe does not detach the tin. It is also a delicate work to add a new fitting to a pipe already in place. M. Hamon gets over these difficulties to a certain extent by supplying pipes and fittings of all kinds.

At one time the relative prices of tin and of lead were such that, taking into account the greater resistance offered by the first metal, and consequently by diminishing the total thickness of the pipe, it was possible to obtain pipes of the same strength at the cost of lead. It is not so to-day, and this circumstance involves an increased price as regards the compound pipes, which would tend to reduce their general adoption if the sanitary phase of the question be not properly considered. Service pipes of tin and lead cost at present about 9d. a yard more than corresponding ones of lead alone. It has to be remembered that in diminishing the thickness of the pipes they are rendered more susceptible to the influence of exterior shocks, and besides this there is more loss in selling them for old metal, because the price of the tin is lost.

Sea Water Baths for London.—The Colosseum, which has been standing and falling to decay for so many years, has at last found a use. This is to supply an institution which is much required in England generally, but more especially in London, namely, a complete suite of baths of all kinds. The building will provide ample accommodation for most sumptuous Turkish baths, immense swimming baths of sea and fresh water, and suites of most elegant and commodious private and medicated baths of every description. The surplus space of the plot of land for the Colosseum buildings extending over two acres—stretching from Albany-street to the Regent's-park—will be laid out as a winter garden, and the block of buildings facing Albany-street will be partly rebuilt and converted into Club Chambers. This will be the work of a company called the Colosseum Spa Company (Limited), and will be one of the grandest schemes in London, the plans for which have been designed and prepared by Mr. Walter Emden, Architect, of 8, Adam-street, Strand, who has built some of our latest theatres. The character of the buildings will be Moorish, and the cooling room of the Turkish bath, which will be under the celebrated dome, will be one of the most magnificent in the world. The exterior will be fanciful in character and the alterations to the existing buildings and the appearance of the handsome mosques and kiosks in the winter garden will greatly add to the general effect. We hope shortly to give a more detailed description of the interior arrangements and the uses the building is to be put to.

A BERLIN RAILWAY STATION.

The goods station of the Berlin-Potsdam-Magdeburg Railway at Berlin, is separated from the passenger station, and consists of a long street 60 ft. wide, on both sides of which are erected various sheds. Corresponding with the use of the main lines of rail, the shed for departing goods is placed on the right-hand side of the street, and that for arriving goods on the left-hand side; at one end of the sheds are situated the necessary offices, whilst at the other is the customs office, and that of the depôt for departure freight, and a separate apartment for chemical produce. Along the outer sides of these sheds run lines of rails, converging to a large turntable, and connected with each other by means of sidings and switches, offering ample facility for the arrangement of the traffic, and the shunting of the arriving and departing trains. These sidings and switches are arranged in such a manner that shunting engines may be used on both sides of the sheds without the engines on the one side interfering with the movements of those on the other side of the sheds. The lines of rails are connected behind the buildings by means of a travelling platform, steam worked; empty wagons can thus be transferred in the shortest time from the arrival to the departure side, or they may be removed to sidings, whence they can be taken for immediate use without interfering with the traffic on the main lines. A shed 313 ft. long, and 30 ft. deep, used for the re-loading of goods is erected between these reserve lines of rails; to the south of this shed all the lines of rails are connected with each other, so that trains can be made up by the shunting engines without using the steam traverser. The convenient and economical arrangement of small turntables might have been adopted here with great advantage, but the goods wagons of most railways of Northern Germany are so long and have such a great wheel base, that no turntable of less than 24 ft. diameter would be of any use; and turntables of such a large diameter require not only a great distance between the lines of rails, but a great amount of power is besides necessary for turning them when loaded with long and heavy goods wagons. The eastern part of the goods station is used for the raw product traffic, whilst the northern part communicates with the eastern docks of the navigating channel that runs along the boundary of the city of Berlin. The goods station contains besides two warehouses for corn and flour, ample spaces for the storing of bricks, stones, coke and coals, and a round shed for 16 goods and shunting engines.

The immense traffic at the goods station at Berlin requires a numerous staff, which is still more increased by the circumstance that at Berlin is situated the bureau of the goods manager of the whole line, so that the staff of the chief office is added to that of the local office. The rooms above the offices are appropriated as official residences for the chief officers of the goods department, whilst the basements offer ample accommodation for porters and labourers. All the offices, rooms, and passages are heated by means of hot water to a temperature from 60° to 70° Reaumur.

The shed for export goods has a length of 631¼ ft., that for import goods a length of 750¼ ft., whilst the width of each is 48 ft. The chief object in these sheds was to make them entirely fireproof and to avoid as much as possible the use of any timber; they were, therefore, built entirely in brickwork with iron window sashes, door frames, and sliding gates, iron roof, and stone flooring; the loading platforms at the side of the rails are also of stone, and with the exception of a narrow platform of 3 ft. wide at the open side towards the street no timber has been used. In order to reduce still further the danger of fire that might originate amongst the stored goods, fireproof walls 1½ brick thick have been erected at distances of 151 ft. apart; these partition walls have two openings which can be shut at once by means of iron sliding doors. It is thus not only possible to localise a fire, but the divisions offer great facility in the classification of goods. This distance from centre to centre of the abutment piers in the main walls of the sheds is 17 ft., and each bay between two piers contains at the side towards the street alternately an opening for receiving goods or a small window 5 ft. above the floor; at the side towards the line of rails each bay is provided with an opening for the more convenient loading of the goods wagons.

As will be seen from the engraving, the projecting part of the roof does not form a continuation of the main roof, but has been considered as a separate structure sloping towards the walls of the shed. By means of this construction a wall surface 5 ft. high is obtained above the projecting roof, but below the main roof; it is constructed entirely of iron, and, with the exception of the brick piers in connexion with the fireproof partitions, is covered along its whole length with glass, providing light so amply that lights were no longer required.

The projecting roofs, as well as the main roof, are covered with corrugated sheet iron; the covering of the former roofs, however, does not extend close to the walls of the shed, but terminates over the gutters which run along the walls, and are covered with planking, 1½ in. thick, and 20 in. wide, for protection against snow. Between the roof and the planking a space of 1 in., the height of corrugation, is left for the passage of the water. Discharge pipes, 6 in. in diameter, placed at distances of 68 ft., effect the communication between gutters and sewer.

The platform at the street side is 3 ft. wide and 2 ft. 6 in. high above the level of the street, but the platform at the side of the line of rails is 6 ft. wide and 3 ft. 6 in. high above the rails.

The flooring of the sheds consists of Plotzkeyer stones, 18 in. square and 2½ in. thick, bedded in cement on 6 in. of cement concrete. Though the stones have been carefully selected, the flooring is still rough, and produces dust. In order to get over these disadvantages, it is intended to cover the whole flooring with a thin layer of asphalte without the addition of gravel. The total cost of the flooring, inclusively of the concrete foundation, amounted to about 9d. per square foot. The ventilation of the sheds is effected by means of air tubes, made of strong plate iron, and placed below the roof at distances of 34 ft.

The main roof consists of rafters which are 48 ft. long placed 17 ft. apart, and are constructed, as will be seen from the engraving in connexion with the rafters of the projecting roofs. The main rafters of the roof consist of an upper and a lower frame, the former of which is formed by angle irons 2¼ in. by 2½ in. by ⅜ in., and the latter by angle irons 2½ in. by 2½ in. by ⅜ in.; at the meeting points of the diagonal and vertical ties, ⅜ in. plates are rivetted between the angle irons. These two frames or flanges of the main girders are connected at the supporting ends by two angle irons, the outside one of which runs vertically, and the inside one in an inclined direction, so that they cover at their connexion with the lower frame, the width of the wall of the shed for the support of the rafter. The angle irons are connected at this end by means of two other angle irons 2½ in. by 2½ in. by ⅜ in. with a horizontal plate which rests on the cast iron bed plate, and is fastened to it, and to the brick wall by two bolts, 4 ft. long and ¾ in. diameter, preventing in this manner the lifting of the roof. Between the ends of the rafters are fastened the special frames into which are secured the large iron window sashes, forming thus the vertical continuation of the wall up to the main roof.

The rafters of the projecting roofs are connected to the rafters of the main roof by means of a triangular angle iron bracing. The lower side of the triangular rafters of the projecting roof is connected at one end with the lower curved side of the main rafter, its other end being connected with the free end of the upper side. This lower side of the triangular rafter has an inclination of 1 : 4 towards the wall of the shed; it also carries the covering for the roof, leaving the upper side entirely free, and consists of two angle irons 1¾ in. by 1¾ in. by ¼ in., and a vertical bar 1¾ in. by ¼ in.; it is besides connected at the middle of its length with the upper frame of the main rafter by means of two angle irons 1¾ in. by 1¾ in. by ¼ in.

The purlins, consisting of angle iron 2¾ in. by 2¾ in. by ⅜ in., are placed upon the rafter of the main roof at distances of 6 ft. 1½ in. and 5 ft. 11½ in. respectively, and the three central purlins are supported over ⅓ of their length by an angle iron 2 in. by ¼ in.; whilst the outside purlins are supported on the side walls of the sheds by means of two T-irons 2½ in. by ¼ in., which form at the same time the frames for the window sashes.

The purlins of the projecting roofs are formed of Σ-iron and are placed at distances of 7 ft.; the central purlins are 7 in. high and 3½ in. wide, the central web is $\frac{5}{16}$ in. thick and the flanges ⅜ in., the purlins at the ends are 4½ in. by ¼ in. and 2$\frac{5}{16}$ in. by ¼ in. In order to prevent a lateral movement of the rafters, each pair of the latter are connected by wind ties, of bar iron, 2 in. by ⅜ in., Fig. 6.

The following are the general weights of the roof:

	lb.
Weight of corrugated iron per foot of rafter 2×17...	34
Weight of the roof per foot of rafter	86.84
Total	120.84

For which 125 lb. have been taken.

Load on Roof.

	lb.
Pressure of snow per square foot 14 lb., whence per foot of rafter	238
Pressure of wind per square foot 3 lb.	51
Total	289

For which 295 lb. have been introduced into the calculation.

The sliding doors constructed of corrugated iron are 8 ft. 2 in. high and 8 ft. 6 in. wide, and weigh altogether 520 lb. or 7.46 lb. per square foot. The cost per door inclusive of the top and bottom girder amounted to about 9*l*.

The cost per square foot of the roof, inclusive of the cover of corrugated iron, &c., amounted to 2s. 1d., and the total cost of each of the two sheds per square foot of the covered area was 6s. 6d. The roof was constructed by F. Wöhlert, engineer, of Berlin, at the following outlay.

Departure goods shed, with a covered area of 48,070 square feet (inclusive of projecting roofs):

	Tons	Cwt.		Per ton. £	£	s.
Rolled iron ...	104	10	...	23	2403	10
Cast iron ...	3	0	...	11	33	0
Bolts, &c. ...	1	2	...	38	39	7
Total ...	108	12	...	...	£2475	17

Or about 1s. per square foot (weighing 5 lb.).

Arrival goods shed, with a covered area of 57,152 square feet (inclusive of projecting roofs):

	Tons	Cwt.		Per ton. £	£	s.	d.
Rolled iron ...	124	5	...	23	2858	0	0
Cast iron ...	3	10	...	11	38	10	0
Bolts, &c. ...	1	4¼	...	38	40	8	6
Total ...	128	19¼	...	...	£2936	18	6

INDIAN RAILWAYS.—The survey of the country below Sakkar for an extension to Kotree is about, it is said, to be undertaken. Some of the staff of the upper section of the Indus Valley State Railway have been directed to hold themselves in readiness to proceed with the survey in question. The Madras Government has considered it expedient that precautions as to inspection and signalling shall be adopted in the cases of the Palar, the Poiney, and the Goorjattune bridges on the Madras Railway. The speed of trains is to be slackened to four miles per hour in crossing the Palar bridge, which they will not be allowed to cross at all until they have received an "All right" signal. The ground for these precautions appears to be the unsatisfactory condition of the foundations of the bridges in question.

STEAM ENGINE COEFFICIENTS.

TO THE EDITOR OF ENGINEERING.

SIR,—In concluding your very able summary of the arguments of the past few weeks on steam engine coefficients, you appear to arrive at the conclusion that the formula of Professor Rankine,

$$\frac{r\,p_m}{p_i},$$

not only expresses "the ratio of the whole gross work of steam on piston to gross work during admission," but, being divided by 10, gives also the efficiency of the steam in an elementary engine, or, in other words, the ratio of the heat converted into work, to the total heat used, which would be at variance with the Professor's formula, page 343, art. 265, for the "efficiency of the fluid in elementary heat engine=

$$\frac{H_1 - H_2}{H_1} = \frac{T_1 - T_2}{T_1 + 461.2}."$$

The efficiency for instance between the limits of temperature of 293° down to 115° could never attain to

$$\frac{293° - 115°}{754°} = 0.239.$$

Your obedient servant,

Norwich, December 12, 1871. W. W. PARR.

[We thank our correspondent for directing attention to what is possibly an ambiguous point in our article; but we think that if he reads that article again he will see that he has attached to the word "efficiency" a different meaning to that which we intended it should bear. In our article we explained that when steam expanded according to the formula,

$$p \propto v^{-\frac{1}{n}}$$

the total work which a given volume of steam could perform if expanded to infinity would be equal to ten times that portion of the work performed prior to expansion. The expression:

$$\frac{r\,p_m}{p_i}$$

gives the work done by the steam in expanding r times in terms of the work done prior to expansion, or, in other words, in *tenths* of the total work which the steam is capable of performing if expanded to infinity, supposing that expansion to take place according to the law above stated. On the other hand, supposing the expansion to take place according to the law

$$p \propto v^{-\frac{11}{10}}$$

as is the case under certain circumstances, then the total work which the steam would be capable of performing if expanded to infinity would be equal to seventeen times that done prior to expansion; and the expression $\frac{r\,p_m}{p_i}$ would give the work done in *seventeenths* of this maximum quantity. It will thus be seen that Mr. Gray's coefficients express the "efficiency" of the steam in proportionate parts of the total work which that steam would be capable of developing if expanded to infinity under the conditions supposed. As regards the formula,

$$\frac{T_1 - T_2}{T + 461.2},$$

quoted by Mr. Parr, it gives the true "efficiency," when that term is taken to mean "the ratio of the heat converted into work to the total heat used." In the case of steam, however, or other fluid not a perfect gas, it is essential that the quantities, T_1 and T_2, should be represented, not by the sensible heat of the steam merely, but by that temperature *plus* the latent heat. Thus in the case of steam being reduced from a temperature of 293° to 115°, the efficiency would not be represented by 0.239, as calculated by our correspondent, but there would have to be substituted for 293° and 115° in the formula the total heats of steam having these temperatures. These total heats are, according to Regnault, 1203.3° and 1035.4° respectively, and the calculation will thus become:

$$\frac{1203.3 - 1035.4}{1203.3 + 461.2} = \frac{167.9}{1664.5} = 0.1009.$$

We may take this opportunity of stating that we have received another letter from Mr. Gray on the subject of steam engine coefficients; but as this letter is accompanied by some diagrams which could not be engraved in time for the present number we have to postpone the publication of the letter until next week. We have also under the circumstances postponed our second article on the subject as it relates in some degree to matters brought forward by Mr. Gray.—ED. E.]

THE FISH TORPEDO.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to the article in your issue of 24th ultimo, on "The Fish Torpedo," of Mr. Robert Whitehead, for the sole interest in the manufacture of which, it is said, our Government are about to pay (or have already done so) the sum of 15,000*l*., I beg to inform you that in 1862 I constructed and tried at Portsmouth a torpedo on precisely the same principle as Mr. Whitehead's. It consisted of an elongated tube, the forward half of which contained the explosive compound, which was exploded on hitting its mark by ordinary detent triggers on the outside of the case. The after portion of the tube served as a reservoir for highly compressed air, the initial pressure of which was about 600 lb. per square inch. This served as the motive power for a small engine actuating a simple feathering paddle on the outside of the torpedo. By a simple arrangement the torpedo could be propelled at any depth at a great speed, and its course indicated by a small float on the surface of the water, was always under the control of the assailant, and, notwithstanding strong adverse currents or a change of position of the enemy's ship, could unerringly be steered to its mark.

During my day's trial with the apparatus at Portsmouth a series of mishaps occurred in my two attempts to launch the torpedo, so that at the end of the day, finding no assistance or encouragement was given me by the authorities (who at the outset had declared themselves totally adverse to the use of any such weapon for submarine warfare) I declined any further trouble or expense in the matter.

The first drawing of the torpedo sent to the Admiralty was lost, but at their request I sent a duplicate, which has not been returned, and in answer to my late application to them for a further trial, they reply that "they have no desire to make any further trial of the torpedo."

It will thus be patent that our Government are paying a large sum of money for an invention which, I believe, has no claim to novelty and can be used by any other nation if considered of sufficient value.

I am, Sir, yours obediently,

GEORGE WARSOP.

Queen's-road, Nottingham, December 13, 1871.

VALVES FOR BLOWING ENGINES.

TO THE EDITOR OF ENGINEERING.

SIR,—Other engagements prevented me from as usual looking with interest over ENGINEERING on the 1st inst., and so I have not seen the letter of "Veritas," referred to in your paper of the 8th.

Having had occasion to visit the Solway Works at least weekly while Mr. Inglis's valves were in use there, I watched the working of them with very great interest. I had expected good results from them, but I was never fortunate enough to see the fair results from them which Mr. Inglis describes, and I believe I noted the working of the valves twenty times to each time he had an opportunity of doing so. The opinion at which I arrived is, that the valves knocked themselves to pieces by their unnecessary weight, and on account partly of the guards not being covered with rubber, as well as the rollers. I believe the principle of the valves to be good, and that they will yet be got to work elsewhere satisfactorily.

I am, Sir, your most obedient Servant,

H. M. M.

MACHINE FOR FLANGING BOILER PLATES.

TO THE EDITOR OF ENGINEERING.

SIR,—In reply to Mr. Adamson's letter, I beg to say that it is impossible my husband could have made a statement that he had not received any royalty in respect of his patent, the fact being that, to my knowledge, Mr. Beeley had paid him royalty immediately the machine was started—now nearly two years ago—and to confirm my statement I may mention I have this week seen the receipt, given by my husband to Mr. Beeley for the amount paid.

As regards Mr. Adamson's interference with the patent, the facts are these: he sent for my husband, and said he wanted one of his flanging machines, but stated he wished to make it himself. My husband replied that Messrs. Muir and Co. had hitherto made his machines, and he could not allow Mr. Adamson to make it himself. At this time my husband was foreman boiler-maker for Mr. Beeley, and for several nights after the interview to which I have referred one of Mr. Adamson's leading men came to our house, and did all he could to induce my husband to let Mr. Adamson make the machine himself. My husband still refused, and it resulted in Mr. Adamson writing to Messrs. Muir and Co., stating that he wanted one of "Hanson's patent flanging machines;" and, therefore, you will observe it was not because, as stated in Mr. Adamson's letter, "his engineering tools were fully employed," but because my husband refused to allow Mr. Adamson to make the machine himself, that he gave the order to Messrs. Muir and Co.

Messrs. Muir and Co. then made a quotation to Mr. Adamson for one of "Hanson's patent flanging machines," whereupon Mr. Adamson ordered the machine as illustrated in your paper, which order Messrs. Muir and Co. accepted as being an order for one of Hanson's patent flanging machines, and so stated in their reply accepting the order.

Yours respectfully,

Dukinfield, December 13, 1871. E. HANSON.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to Mr. Daniel Adamson's letter, in your publication of the 8th instant, we beg to say that the actual facts are as stated in our letter to you of the 1st instant, and shall be very glad to show you or your readers the correspondence that has taken place relative to this transaction, and leave you or them to decide.

We may again repeat that the machine sold by us to Daniel Adamson and Co. was estimated, ordered, designed, and manufactured by us under Hanson's patent, which our letters and Daniel Adamson and Co.'s fully prove.

We are, Sir, yours truly,

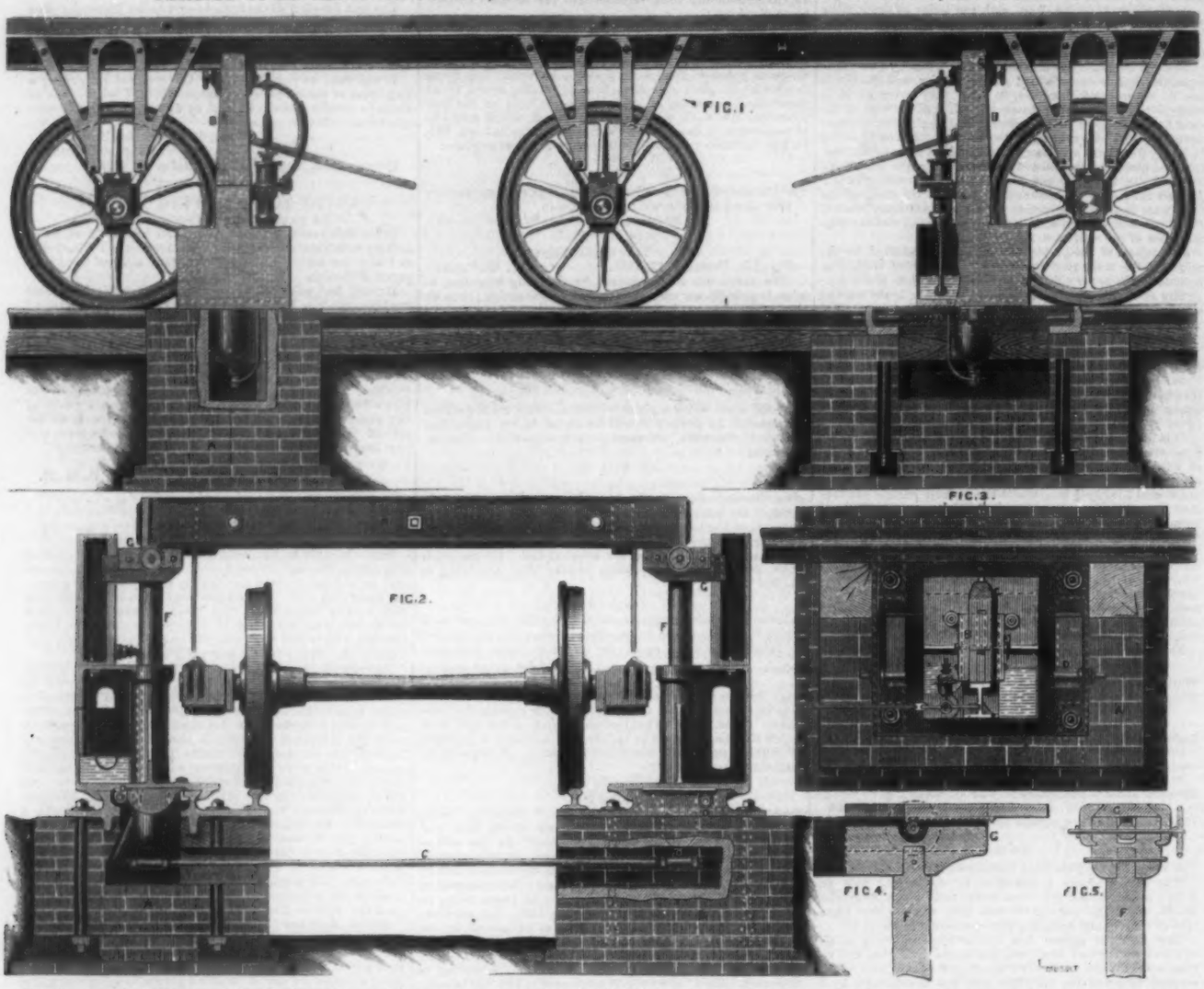
WM. MUIR AND CO.

Manchester, December 13, 1871.

BRITISH STEAM NAVIGATION.—It is computed that there are now 71 steamers of an aggregate burthen of 96,955 tons trading between Liverpool and London and Brazil. Before the close of 1872, it is estimated that the aggregate burthen of these steamers will be carried to 100,000 tons. The ports of Para, Maranham, and Ciara are served by eight steamers of 9038 tons, and steamers also trade to Pernambuco. From London four steamers of 6415 tons burthen run *viâ* Antwerp to Rio Janeiro, Monte Video, and Buenos Ayres, and a monthly service is maintained from Southampton to South American ports. Eighteen steamers measuring 24,606 tons are owned by the Liverpool, Brazil, and River Plate Company, and a new fleet is building for the River Parana Steamship Company, whose vessels sail *viâ* Bordeaux for Monte Video, Buenos Ayres, and Rosario. Twenty-seven steamers belong to the Pacific Steam Navigation Company; these vessels leave Liverpool every fortnight, and sail *viâ* Bordeaux and Lisbon for Rio Janeiro and Monte Video, and passing through the Straits of Magellan join steamers running to Callao, &c.

HYDRAULIC APPARATUS FOR LIFTING RAILWAY CARRIAGES.

DESIGNED BY MR. HENRY LEE CORLETT, GREAT SOUTHERN AND WESTERN RAILWAY WORKS, INCHICORE.



Mr. Henry Lee Corlett, of the Great Southern and Western Railway Works, at Inchicore, has designed and recently patented some very handy arrangements of hydraulic jacks for lifting railway carriages and wagons, and of one of these arrangements we annex illustrations. The particular arrangement shown consists of two pairs of hydraulic jacks, of which one pair is stationary and the other pair capable of being moved longitudinally on suitable bed plates as we shall explain presently. The apparatus is represented in the engravings as applied to lifting a six-wheeled carriage. Fig. 1 being an elevation; Fig. 2 an end view; and Fig. 3 a plan of one of the movable jacks, while Figs. 4 and 5 are enlarged sections of the ram-head, showing the mode of sliding or adjusting the shoe or support at the top.

In these figures, A, A, is the masonry on which the hydraulic jacks are fixed, and B, B, are the several hydraulic jacks with their appurtenances as usual. These jacks may be arranged and fitted so as to be either stationary or capable of sliding either laterally or longitudinally or both. The pumps of each pair of these jacks are connected by a pipe, C, so as to admit of their being worked simultaneously, or the two jacks acting on one end of the vehicle to be lifted may be arranged so as to be worked by one pump. D, D, are screws for sliding the jacks longitudinally, and if desired, other screws may be provided for sliding them laterally. The four jacks thus arranged may be worked as required in pairs at a time. F, F, are the hydraulic rams, each having on the top a shoe or support, G. These rams are mounted with standards adapted to act as vertical guides for the shoes or supports, G, and also to admit of their being moved out of the way in order to allow of a carriage being placed in the position required for lifting, and they are afterwards turned and slid under the frame of the carriage, as shown in Fig. 2 by means of racks and pinions represented in Figs. 4 and 5, or by other suitable means; H is the lower portion of the frame of a carriage lifted off its wheels and supported on the shoes or supports, G, G, as long as required for repairs, the wheels being left on the rails, I, I, ready to be moved away to any required part of the shop. Of course in shops where other hydraulic machinery is employed, and where a supply of water under the requisite pressure is available, the apparatus we have described may be constructed without pumps, the water being admitted to the jacks direct from the supply pipes. The arrangement is, as we have said, a very handy one.

PERMANENT WAY.

To the Editor of Engineering.

Sir,—As one connected with the maintenance of permanent way, I have been a close reader of the articles in your paper on this subject, and would like to make a few remarks on the designs for iron permanent way, as illustrated in your number for last week.

Taking the case of a macadamised country road, we have a rigid surface of metalling on which to run with ease, and without destruction to the vehicle, an elastic wheel is indispensable. This elasticity is obtained through the wood spokes. On a railway this order of things is reversed, and for the rigid engine wheel we must provide an elastic road.

In the designs referred to this has been lost sight of, and Figs. 1 and 2 show a rail-topped girder of the excessive depth of 8 in., requiring a top and bottom tie-rod; this plan would clearly produce a rigid road, most unsuitable for a railway. Turning to Figs. 4 and 5, we have arrangements designed (without a redeeming feature) to give the evil of multiplicity of parts, as, reckoning rivets and bolts, there cannot be less than 5000 pieces to the mile. This is very objectionable, as the rivets invariably get slack, and the bolts would be impossible to keep tight, and soon be found without their nuts.

Figs. 7 and 8 are no better, and the laying in of a simple cross-over road on this system would require a gang of fitters and blacksmiths.

Figs. 10 to 12 quite confuse the eye with their numerous parts.

In designing permanent way it has to be borne in mind that an elastic road must be provided capable of "undulating" under the pressure of the wheels of the train, and for this nothing is so suitable as the cross sleeper road, with the timber protected from decay by creosote, rail not over 5 in. deep, fished joints suspended between the sleepers, proper fang bolts to keep rails to gauge; this way can be laid in with a 75 lb. rail for 15s. per yard.

One great defect of iron roads is that in frosty weather the ground freezes, rendering the structure perfectly rigid, rails thereby get battered and broken, as well as bolts securing them, and springs of wagons besides. With a timbered road the natural elasticity averts the danger of a broken rail. The stated cost of maintaining these iron roads is simply incredible, as it would only allow one man to over four miles of line.

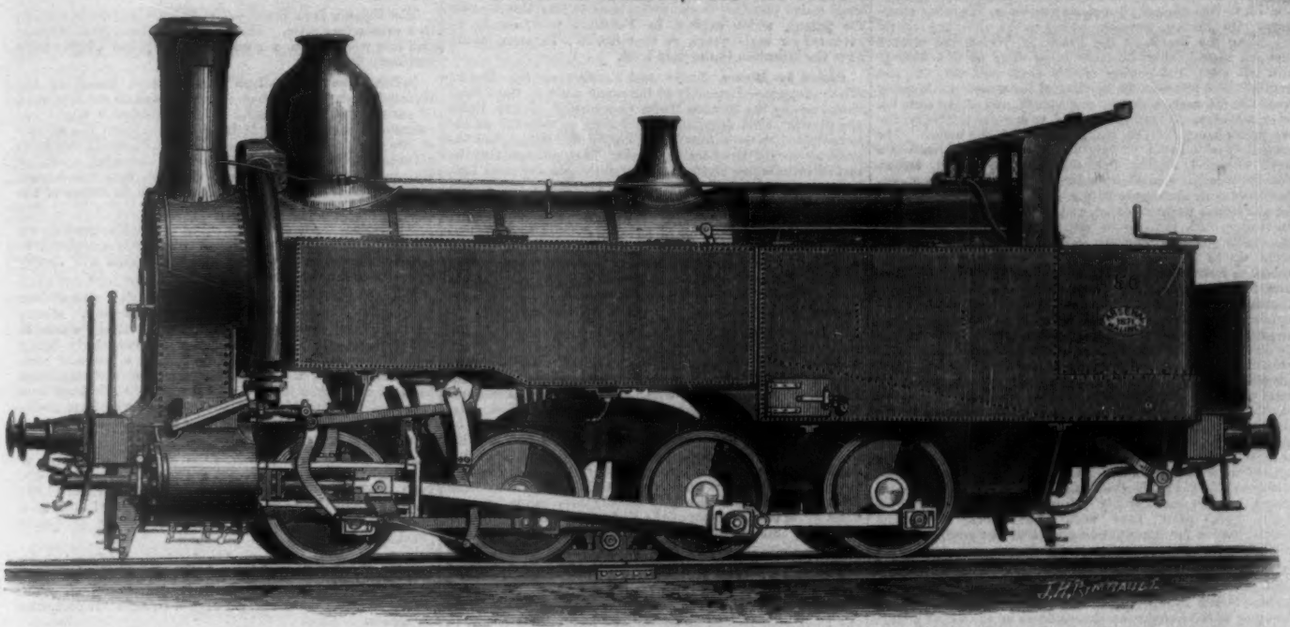
It is to be hoped that in this country no money will be spent on such designs where simplicity has been departed from, and complication and inefficiency introduced in its stead.

I am, Sir, yours truly,
December 12, 1871. W. G.

The Institution of Civil Engineers.—At the ordinary meeting of this society, on Tuesday, the 12th inst., Mr. C. B. Vignoles, F.R.S., President, in the chair, after the transaction of the purely formal business, it was resolved unanimously, that, "considering the critical condition of His Royal Highness the Prince of Wales, and the deep anxiety which the nation is now suffering, this Institution do show its sympathy in the general feeling by immediately adjourning." The Annual General Meeting, "to receive and deliberate upon the report of the Council on the state of the Institution, and to elect the officers for the ensuing year," is announced for, and must, according to the Statutes, take place on the 19th inst., being the Tuesday next previous to Christmas Eve.

LOCOMOTIVE FOR THE BELGIAN STATE RAILWAY.

CONSTRUCTED AT THE ARSENAL AT MALINES, FROM THE DESIGNS OF M. STEVART.



THE locomotive which we illustrate above is one constructed at the arsenal at Malines, and set to work last year upon the steep gradients of 1 in 35, on the Belgian State Railway between Liege and Ans, up which gradient it takes easily a load of 200 tons. More recently five other locomotives of the same class have been constructed for private firms, and these engines have now supplanted the system of rope haulage formerly adopted on the incline just mentioned. The engine has outside cylinders 18½ in. in diameter, with 1 ft. 9½ in. stroke, and it is carried on eight coupled wheels 3 ft. 3½ in. in diameter, the axles being 4 ft. 11 in. apart from centre to centre, making the total wheel base thus 14 ft. 9 in. The diameter of the boiler barrel is 4 ft. 6¾ in., and it contains 251 tubes 1.77 in. in diameter outside, and 12 ft. 10¼ in. long between tube plates. The firebox heating surface is 121½ square feet, and the tube surface 1358½ square feet, the total heating surface being thus 1480 square feet. The boiler is worked at a pressure of 120 lb. per square inch. The tanks contain 880 gallons of water, and the coal bunkers have a capacity of 78 cubic feet, while the weight of the engine in working order is about 49½ tons.

This locomotive, as will be seen, includes several features worthy of special notice. Thus, in the first place, the firegrate area is unusually large, the firebox being constructed on the Belpaire system, with a flat top as shown, and being made of a trapezoidal form in transverse section, so that its lower part extends laterally over the tops of the wheels. In this way there is obtained a firegrate 7 ft. 4 in. long by 5 ft. 9½ in. wide, the area being thus about 43 square feet.

Another feature in the engine is the valve gear, which resembles in its general arrangement the Walschaert's gear already described in our pages (*vide* page 461 of our second and page 33 of our fourth volume), but differing from the latter, in the fact that no eccentric is employed. In the Walschaert's gear, the oscillating motion of each expansion link is given by an eccentric or overhung crank on that side of the engine to which the link belongs; but in the engine we are describing, these eccentrics or overhung cranks are done away with, and each expansion link is caused to oscillate by being attached to a shaft which extends across the engine, and which is provided at its end with an arm which extends downwards and which is coupled to the crosshead on the opposite side of the engine to that on which the link is situated. The arrangement will be understood by reference to the engraving. It will be noticed that the valve chest cover joint is placed obliquely so as to give clear access to the face when the cover is removed.

The brake consists of a pair of cast-iron shoes, applied directly one to each rail between the central pairs of wheels. In brakes of this kind previously used, it has been usual to use the frames as the *point d'appui* of the thrust, exerted upon the shoes, and the result has been that engines so fitted were apt to ride "hard" when the brake was applied. In the engine we are describing, however, the thrust upon the brake shoes is resisted by the undersides of the axle boxes, and that portion of the weight which rests upon the shoes when the brake is applied is thus carried through the intervention of the springs. The wheels, it will be noticed, are of the disc class, and have the counterweights forged in one piece with them. In conclusion, we should state that the engine we have described was designed by M. Stevart, under the direction of M. Belpaire, the engineer-in-chief of the Belgian State Railway.

THE HOOSAC TUNNEL.—About 700 men are at present employed in blasting through the Hoosac mountain. When the tunnel, which has been 17 years in course of construction is completed, it will be nearly five miles in length.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a larger attendance on 'Change at Middlesbrough than there was even on the previous week. Prices were again advanced a trifle. There were very few sellers and those who were fortunate enough to be able to dispose of pigs to be immediately delivered could have got prices which were ruled by No. 3 being 22*s.* 6*d.* The demand is so heavy that the relief which many smelters expected they might obtain after the closing of the shipping season has proved delusive, and every description of pig iron is scarce. It is evident that quotations will have an upward tendency until the turn of the year, and even then it is every way probable they will remain firm. Last week we stated that the shipping season having closed makers were doing their utmost to make up the arrears they had fallen into with their home contracts. In this good intention they have met with a sudden check. At various collieries in the north the pitmen have passed regulations which restrict the production of coal. This being so and the demand of the Cleveland district being so enormous, the iron trade is considerably inconvenienced, and the yield of the blast furnances is also restricted. In addition to this there are numerous complaints that the North-Eastern Railway Company have not a large enough rolling stock to cope with the rapidly growing district surrounding Middlesbrough.

The Finished Iron Trade.—The demand for all classes of merchant iron is still heavy. Prices are now as follows: Rails, 8*l.* to 8*l.* 5*s.*; plates, 10*l.* 15*s.* to 11*l.*; angles, 9*l.* 5*s.* to 9*l.* 10*s.*; bars, 8*l.* to 8*l.* 5*s.*

Engineering.—In this branch of industry there is nothing new to report.

Shipbuilding.—On the Tyne, Wear, Tees, and Humber, there are dozens of steamers, some of which are of great size, in various stages of construction, and as rapidly as the busy yards launch a vessel its place is occupied with the framework of another. Most of the builders have orders which will keep them fully occupied far into next year.

The Pollution of Rivers.—Yesterday, at the Middlesbrough Town Council, it was gratifying to hear that that body resolved to place itself in communication with other public bodies on the banks of the Tees with a view, if possible, to stop the pollution of the river in the upper reaches Seeing that an extensive water supply for human consumption is obtained from that river, it is highly essential that every means should be adopted to make it as pure as possible.

The North-Eastern Railway and Middlesbrough.—During the week the Middlesbrough authorities have had under discussion the proposed Bill of the North-Eastern Railway, by which they seek for power to construct a line from a portion of the Durham coalfield to meet the growing requirements of this iron-making district, where the consumption of coal and coke is so prodigious. The projected line will interfere with highways in Middlesbrough, and the council, as a matter of form, dissented from the project in order that they may take the opportunity of meeting the promoters of the Bill, and arranging their differences.

The River Tees.—A number of the owners of foreshore on Tees-side to which we referred last week have arranged respecting the price to be fixed by arbitration for the sale of the land, now the property of the Tees Conservancy Commissioners, who have reclaimed it, and who were bound to give the owners of the foreshore the first chance of purchasing it.

The Late Mr. Walter Pease.—We regret to announce the death of Mr. Walter Pease, of the firm of Pease, Hutchinson, and Co., of the Skerne Iron Works, Darlington, which took place at Darlington on the 6th inst.

WASTE OF WATER.—It is well known that an immense amount of waste is caused owing to the imperfect organisation of our general arrangements. Our gas, our coal, our food are all lavishly thrown away because we do not take the trouble to economise them; and as with these articles so with our time and labour. We grudge no expenditure of these unless spent on endeavours to discover the proper method of saving them. Some idea of what might be done by improved management is given in a report drawn up by the Chief Surveyor of St. Pancras, and laid before the vestry of that parish at its last meeting, on the subject of "street watering." In 1856 the surveyor, Mr. Scott, had a diary of a water-cart kept during a week in the height of the watering season, and he found that through an average working day of 10½ hours (exclusive of the intervals for breakfast and dinner) the time of the cart was thus occupied:—Filling at the stand-post, 1 hour 20 minutes; distributing water on the roads, 50 minutes; travelling to spread the water and back to the stand-post, to and fro, 8 hours 7 minutes. Since that year additional stand-posts have been established, and from observations taken in 1864 and again in 1867, Mr. Scott finds the following results:—Filling, 2 hours; distributing, 1 hour and 30 minutes; travelling to and fro, 60 hours and 30 minutes. This, however, is a favourable average; as, where only one cart works from a stand-post, so that there is no loss of time by waiting, the maximum time occupied in filling is but 2 hours and 10 minutes. As the distributing will occupy only about 1 hour 36 minutes, the time occupied in travelling to and fro is 6 hours 14 minutes under the most favourable circumstances. It may, therefore, be taken that only one-fifth of the working day is occupied in filling, about one-seventh in spreading the water, and about two-thirds of the day in travelling to and fro. By additional waterposts it has been reduced nearly to the minimum under the existing arrangements, and no further economy can be effected without a complete alteration of the system. A change proposed by Mr. Scott is the adoption of a water-van, that will hold 450 gallons, instead of the ordinary water-cart, that holds about 220 gallons. This water-van, he alleges, will be in every way an improvement upon the water-cart, which does not distribute the water equally over the surface, and by reason of the height of the distributor from the ground causes a cloud of dust to arise (whenever the weather is hot and the surface dry) from the force with which the water falls upon the road. The van, holding 450 gallons of water, will occupy 9 minutes in filling and 6 minutes in spreading the water, but it will only occupy 3 hours 15 minutes in travelling to and fro, so that in 7 hours it will accomplish as much work as the present water-cart effects in 10 hours. By substituting 50 of these vans for the 71 water-carts, which during the watering season are employed in St. Pancras, Mr. Scott estimates that a total saving of nearly 1000*l.* a year will be effected, and that a great improvement will be effected in the method by which the roads are at present watered. That some such improvement is desirable is a matter beyond doubt to the many unfortunate foot-passengers who find themselves frequently splashed with mud on a hot and dry summer day owing to the sublime *insouciance* of the drivers of the water-carts at present in use. The time is, perhaps, far distant but it will arrive some day, when the roads will be paved with asphalte and thoroughly washed each morning by means of a tube of india-rubber, or some equally simple device; and neither vans nor water-carts will be required to assist in impeding the traffic and to transfer the dirt from the streets to our garments.—*Pall Mall Gazette.*

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Glasgow Pig Iron Market.—Both on Wednesday and Thursday last there was a firm market, prices varying from 70s. 7d. to 70s. 9d. cash, but closing easier on Thursday afternoon. On Friday, however, owing to the alarming reports regarding the health of the Prince of Wales, the market drooped considerably, business being done at 69s. 7½d. to 69s. 9d. cash, and closing at 69s. cash, and 69s. 6d. one month. The prices at the opening of the market on Monday were 69s. 8d. cash, and 69s. one month, and at the close 9d. of an advance. A further advance took place yesterday, the top prices being 69s. 7½d. cash, and 70s. 3d. one month. The market opened easier to-day, 69s. 4d. to 69s. 2d. cash in a week accepted, closing flat, sellers at 69s. cash, buyers 68s. 10½d. cash. Considerable anxiety is expressed by manufacturers as to the supply of pig iron. In fact, the demand for pig iron is unprecedented, and an advance in prices seems inevitable. An industrious spirit prevails amongst most of the working classes, who are anxious for constant employment up to the holiday season. The dulness usually incident to December and early in January in articles like iron may temporarily influence prices, but it is generally thought that the reaction will be certain and the rebound great. These opinions have been expressed by many of the most experienced in business and prices, and a careful study of the prosperous state of trade here, whether as regards the comparative stocks in hand, the present and prospective demand for consumption, the iron contracts ready to be given out for next year, and the general promising condition of trade on the Continent, indicate that there is a bright future for the iron trade in Scotland. Gartsherrie No. 1 and Coltness No. 1 are both quoted at 94s. per ton, the highest figure they have reached during a quarter of a century. Other brands are quoted as follows: Calder No. 1, 81s.; Summerlee, 80s.; Glengarnock, 79s.; Langloan and Shotts, 78s. Last week's shipments fell considerably below the average returns for many weeks past. They were 11,163 tons, as against 10,652 tons in the corresponding week of last year.

Proposed Amalgamation of the Caledonian and North British Railway Companies.—This project is likely to meet with considerable opposition from the municipal and other public bodies in Scotland. It has been approved of at a meeting of the Caledonian shareholders by the use of a large number of proxies in the hands of the chairman; but it is evident that it will not be carried at a canter through Parliament. Opposition is to be given by the Town Council of Dundee, and other municipal bodies and royal burghs have been strongly urged to join in giving opposition. The Town Council of Edinburgh had the matter under consideration yesterday, and others will follow suit. It is even proposed to hold a national meeting on the subject.

Aberdeen Harbour Works.—The works at the diversion of the River Dee at Aberdeen are now in a very forward state, and should no untoward circumstance arise, it is fully expected that the new channel will be opened next month. The new south breakwater works are wholly suspended for the season. Operations are begun in connexion with the removal of the point of the Inches. When this part of the new works is complete, there will be greatly increased facilities for launching ships from the shipbuilding yards at Footdee.

New Dock at Berwick-upon-Tweed.—The Harbour Commissioners for Berwick-upon-Tweed have applied to Parliament for powers to construct a new wet dock on the south side of the river, and near to the entrance to the harbour. The estimated cost of the dock is 40,000*l.* At their last meeting the Town Council of Berwick were asked to give their assent to an application from the Harbour Commissioners to acquire certain properties belonging to the Corporation for the erection of the dock; and, after considerable discussion, the Council assented to the application. The new dock is expected to prove of great advantage to the maritime interests of the Border port.

Official Report on Clyde Navigation Works.—Mr. J. F. Bateman, consulting engineer to the Clyde Trust, has just presented to that body an elaborate and able report on the various operations now being carried on under their jurisdiction for the improvement of the river navigation. Mr. Bateman offers a great deal of valuable counsel as to the future of the river, and the gigantic works proposed to be undertaken by the Trustees; speaks approvingly of the Plantation Quay, Sticherces Docks, and other improvements; and pays a high compliment to Mr. Deas, the engineer of the Clyde Trust, for the intelligence, zeal, and ability displayed by that gentleman in carrying out the costly and extensive works for which the Trustees have obtained Parliamentary powers. It may be added that the Trustees of the Clyde navigation have at the present time such an enormous amount of work on hand or projected that it is expected to take fully sixteen years to complete it, and so provide that dock and harbour accommodation and facilities which the ever-widening trade of the port demands.

The Glasgow Chamber of Commerce and Technical Education.—At a special meeting of the directors of the Glasgow Chamber of Commerce, at a meeting held on Monday last, the subject of technical education was brought up for discussion in connexion with a motion to the following effect: "That a committee be appointed to consider the question of technical education, with the view to its encouragement in Glasgow, and bring up a report without delay." Prominent reference was made to the Paris Exhibition of 1867, and to the letters written at the time by Doctor Lyon Playfair, and other eminent men of science regarding the relative positions of Great Britain and certain Continental countries in the departments of manufacturing industry. The motion was unanimously agreed to, and a committee was accordingly appointed.

Sir W. Thomson's Patent on Electric Telegraphs.—Before the Judicial Committee of the Privy Council, at a meeting held last week, an application was made by Sir William Thomson, Professor of Natural Philosophy at Glasgow University, for an extension of his patent for testing and working electric telegraphs. After hearing evidence their lordships stated that they would recommend to Her Majesty that the patent, which expires in February next, should be extended for eight years, so that Sir. W. Thomson would have the invention to the year 1880.

Report by Messrs. Leslie and Stewart on the Dundee Water Supply.—Agreeably to the remit made to them some weeks ago by the Dundee Water Commission, Messrs. Leslie and Stewart, civil engineers, Edinburgh, have made an interim report on the future water supply of Dundee, and the probable cost of the necessary works. They estimate that the cost of introducing eight million gallons per day from Lintrathen will be 111,424*l.*, while Mr. Bateman's calculation for the same quantity by the Monikie route, is 149,891*l.*, making a saving on this head of 38,467*l.*, while the Monikie supply would be available in addition to that from Lintrathen. The Commissioners have resolved to lodge a Bill for carrying out the scheme of Messrs. Leslie and Stewart; it has also been resolved that the borrowing powers under the proposed new Bill may safely be reduced to 220,000*l.*, instead of 250,000*l.*, according to the Bill of last session.

The Short Time Movement in Scotland.—In the engineering and allied trades the question of the reduction of the hours of labour is assuming a considerable degree of importance. The workmen of Edinburgh and Leith and Dundee seem to have taken the lead; but the movement has now assumed much prominence in Glasgow, Aberdeen, Kirkcaldy, and other places, and the general feeling seems to be that 51 hours per week is to be the ultimatum by which the men intend to abide. A number of meetings have been held during the last few weeks in the towns just named, and circulars have in some instances been issued to the employers with the ultimatum. Concessions have already been made by some firms. For instance, two of the Kirkcaldy firms have offered 54 hours and weekly pays; Messrs. Mirrlees, Tait, and Watson, Glasgow, have given an advance of ¼d. per hour; and in other cases the 54 hours system has been offered by the employers. The Dundee iron trades' employés held a large meeting on Monday evening in furtherance of their views. It was addressed by no fewer than three members of the Town Council, one of whom is an employer of labour in one of the building trades.

FOREIGN AND COLONIAL NOTES.

The St. Lawrence.—Mr. Page, Canadian Government engineer, estimates that the widening of the channel of the St. Lawrence below Montreal to 300 ft. with a depth of 22 ft. would cost 800,000 dols. Mr. Page further estimates that widening the river to 400 ft. with a depth of 24 ft. would cost 2,500,000 dols.

Our Trade with South America.—The value of British products exported to South American ports in British steamers is computed to have been in 1860, 51,551,210 dols., and in 1870, 66,126,360 dols., showing an increase of 13,575,150 dols. in ten years.

Coal in Russia.—The coal-fields near the village of Zelenin, in the Tula Government, yielded from June 27 to August 27 this year 100,000 poods of coal, 60,000 poods of which were used for cotton spinning purposes. About 63 poods = 1 ton.

Canadian Railways.—Some excitement was occasioned in Orillia a few days since by the arrival of the first locomotive direct from Toronto *viâ* the Muskoka Junction Railway. Several railway dignitaries, including Mr. F. W. Cumberland, managing director of the Northern Railway of Canada, were "on board" the experimental train. The narrow gauge has been adopted for a line between Fredericton and Rivière du Loup, the construction of which has been let to Mr. E. R. Burpee and his associates. A land grant of 10,000 acres per mile has been given by the New Brunswick Government.

Roumelian Railways.—Advices from Enos state that there are now four steamers in that port landing rolling stock and matériel of all descriptions for the section of the Roumelian railways from Enos to Adrianople. An English steamer has also successfully landed at Dedeatch five locomotives for the line. The contractors hope to have the branch from Dedeatch to Adrianople ready for traffic early next year.

Canadian Lighthouses.—The Canadian Department of Marine and Fisheries has now a great number of lighthouses, steam fog whistles, &c., in course of construction. The list is too lengthy for recapitulation, but the department is evidently alive to its responsibilities. Many of the Canadian lighthouses are probably humble structures as compared with Skerryvore, the Eddystone, the Bell Rock, &c., but still they serve their purpose. Among the points at which lights will be shortly exhibited may be mentioned Point L'Original, Ottawa river, and Point des Chênes, Ottawa river.

Bochum Cast Steel.—It appears from the report of the Bochum Mining and Cast Steel Manufacturing Company that the company has been employing this autumn 3000 workmen in its cast-steel works, and 400 men in its coal mines. In spite of the adverse influences of the late war, the value of the cast steel production of the current fiscal year is estimated at 3,500,000 to 4,000,000 thalers. The company's wheel factory has been turning out 60 cast-steel wheels per day. Of cast-steel cannon, 150 breechloaders ordered by the Turkish Government, are now in course of construction. A cast-steel marine gun of 8 in. bore has been experimented upon by the Prussian Ordnance Commission, and with a test of 500 rounds has given very satisfactory results.

A Tunnel at Richmond (Va.).—The Richmond (Va.) city council has appropriated 200,000 dollars for tunnelling Church Hill in that city, in order to bring the eastern terminus of the Chesapeake and Ohio Railroad to tide water, on the James river.

Losses at Chicago.—The total loss of all the United States insurance companies by the Chicago fire has been returned at 82,821,123 dollars. This total is affirmed to be a very close approximation to the aggregate actual sum which the companies have had to disburse.

The Belgian Iron Trade.—The Belgian iron trade remains in a satisfactory state. The production of the blast furnaces and iron works finds a ready sale, and prices display more and more firmness.

Indian Iron Ore.—Iron ore has been found in the Hazareebaugh district which is said to contain not less than 80 per cent. of pure metal. It also contains a slight admixture of manganese. It is stated that there is a surface of 500 square miles of this ore in the Damooda coalfields extending from a few miles, probably 10 miles, south of Hazareebaugh on to Tooree; underneath this rich deposit there is a layer supposed to be about 20 ft. in extent of the finest coal in India.

Wellington, Grey, and Bruce Railway.—The grading on the Wellington, Grey, and Bruce Railway is completed to Paisley. Work on the fourth and last section will shortly be commenced.

New York Harbour.—The work of removing obstructions in New York harbour is progressing favourably. Miners are busy drilling and blasting Diamond Reef, which is 366 ft. long by 255 ft. broad and crops out irregularly, being covered in parts by mud. Coenties Reef, a ledge of rock 250 ft. long by 130 ft. wide, has been removed. Hallett's Point has now been taken in hand. About 750,000 dols. have been expended in improving the navigation of the East river; 150,000 dols. of this sum have been expended in expensive machinery and tools.

Gold Mining in Victoria.—The mining population of Victoria, Australia, amounted at the commencement of July, 1870, to 57,445, of whom 42,844 were Europeans and 14,601 Chinese. The Chinese were principally employed in alluvial mining; very few attained unto the dignity of quartz crushing.

A Great French Bridge.—The fine bridge of Olivet at the entrance to Orleans will be opened early next year. It is built to replace a venerable structure over which Joan of Arc passed to raised the celebrated siege of Orleans. It comprises 22 arches.

Drainage of Torquay.—There is considerable excitement at Torquay concerning the drainage of the town. The Local Board five years ago consulted Mr. Bazalgette, the well-known London civil engineer, and three years since he reported in favour of the irrigation and sewage-farm principle. Thereupon the Board appointed a committee, who visited many towns in England and Scotland to see for themselves the practical working of the plans submitted to them; they also endeavoured to obtain land in the neighbourhood of Torquay for the purpose of carrying out Mr. Bazalgette's recommendation. The matter soon afterwards dropped, and was only revived last October. Mr. Bazalgette was once more consulted, and it was decided to apply for Parliamentary powers for the construction of an intercepting sewer from the grounds near Torre Abbey to Hope's Nose, in the parish of St. Mary Church, a considerable distance to the eastward of Torquay, and there to empty the sewage into the sea. The cost of these works is set down at 30,000*l.*, with an additional 2000 for a roadway and pleasure grounds, exclusive of the cost of land. To this plan there are important objections, and a public meeting has shown strong opposition to the Board's proposals. At a meeting of the Local Board on Saturday, Mr. Appleton, of Torquay, propounded a plan he had prepared for utilising the sewage by pumping it to Bovey Tracey, 9¼ miles distant, the necessary works for which he calculated would cost about 48,000*l.*, and yield a net profit of 700*l.* a year, besides an estate of 200 acres in fee at the end of 50 years. A committee of twelve practical men has been appointed by a public meeting to confer with the Local Board as to the best method to be adopted.—*Times*

Steam Cultivation.—The *Times*, in its notice of the late Smithfield Show, speaks as follows of the increased use of steam cultivating machinery in this country. It says: "Messrs. Fowler have for months been sending out six to eight ploughing engines per week; and it is an incident confirmatory of the profitableness of steam culture that Mr. Thomas Redman, who was the purchaser of the Fowler apparatus about fourteen years ago, and whose experience, therefore, had to contend with the early imperfections of the invention, has just bought another 12-horse power set, at a cost of about 1500*l.* The greatest development has been in the hiring or contract system. Thus, among numerous private firms who steam cultivate for farmers, one in Kent has six double-engine sets, while a contractor in Lincolnshire has now ten sets of machinery, representing a capital of 20,000*l.* The Northumberland Steam Cultivating Company have 20 sets of apparatus, consisting of 40 engines with implements, their capital being 42,000*l.*, and the area of land worked per year about 60,000 acres. The Durham and North Yorkshire Company have 12 sets, with a capital of 42,000*l.*, seven of their sets having been purchased since the Wolverhampton meeting. The York Company have just started with eight sets, and a capital of 15,000*l.*, and the Scottish Company, originated by Lord Dunmore, have ten sets, with a proportionate capital, of which the farmers in each district and county subscribe their share. It is has been well remarked that if these companies can pay dividends of 10 per cent. or more, there is no reason why money should be wanting for such operations upon any scale that is desired, seeing that capital already flows into railroad enterprises paying only 3 to 5 per cent.; and it has been further estimated that there is ample opportunity in this kingdom for the application to steam husbandry of double the amount of capital now invested in railways."

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NOTICE OF MEETING.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 19, at 8 p.m. The Annual General Meeting.

THE "ENGINEERING" DIRECTORY is published this week on the thirteenth page of our advertisement sheet.

NOTICE TO AMERICAN SUBSCRIBERS.

In consequence of the great increase in our American connexion, we have found it necessary to establish a branch office in the United States. Communications may in future be addressed to MR. GEORGE EDWARD HARDING, C.E., *of* 176, *Broadway, New York, who is our accredited representative.*

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of* 1l. 14s. 8d. ($8.32, *gold*) *per annum, payable in advance.*

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ENGINEERING.

FRIDAY, DECEMBER 15, 1871.

CEMENT MANUFACTURE IN INDIA.

AN order has recently been issued by the Governor-General of India on the subject of cement manufacture in that country, from which it would appear, at first sight, that no important works requiring anything more than ordinary mortar had ever yet been constructed there, excepting with cement obtained from England. What, however, we may ask, is to be said with reference to the old buildings, Hindoo, Mahomedan, Dutch, and Portuguese, all over India, under all varying circumstances and climates, which have been constructed with so excellent a cement that the masonry will break anywhere rather than at the joints, although the bricks, as well as the mortar, are stronger than any that are made now? Then, again, even since the British occupation of India, there are to be found works in the construction of which hydraulic and other cements have been required to be used, and which have hitherto stood the test of time, and may, therefore, be presumed to have been efficient for the purposes for which they have been employed. It is true that recently, and especially in the military department, it has been customary for buildings erected at enormous cost to fall down almost as soon as built, and the defective part of the construction has generally been the cement used. The exposures, however, which have taken place in connexion with some of these failures tend to prove rather that the causes of them have been, not the absence of all knowledge of how to make cement in India, but rather the existence of a reign of negligence, corruption, and adulteration, coupled also occasionally with incapacity. The remedy for these defects is, therefore, not the introduction of a new and improved manufacture of cements in India, but the eradication of those evils from the Department of Public Works to which we have just referred.

Had there existed no publications in India on the subject of native cements used on her public works, there might possibly be some slight excuse for the officers of the secretariat, supposing that the art of cement manufacture had been already lost to India, but even that fact would not be sufficient to excuse the chief officers of the executive branch of the Department for their want of knowledge in that respect, for surely a knowledge of cement manufacture must in every country constitute one of the most important branches of knowledge of the civil engineer, and more especially is this the case in a country like India, where very often, in the case of large works, all the cement required has to be manufactured on the spot, all the lime burned, and all the bricks required made under the immediate superintendence of the engineer in charge. Departing now from speculative considerations, let us see what information may be derived from Indian publications, a reference to which might perhaps save the several local governments from the necessity of appointing officers specially to discover for them what has already been published. We have not thought it necessary to search back very far, confining ourselves strictly to well-known professional works, in order to arrive at an amount of information on this subject which will doubtless be found of much value and interest to those concerned in the construction of public works in India. At volume i. of the "Professional Papers of the Madras Engineers" (published in 1839), pages 28 *et seq.*, will be found an interesting account of the manufacture and use of magnesia cement. In order to form the cement, the stone should first be broken up into small pieces, and then placed in a kiln to be calcined. During calcining the heat must not be raised to too high a temperature, otherwise the outside of the magnesia will melt, while the inside remains only half burnt. The most important thing, however, appears to be that the stone should remain in the kiln for at least 24 hours. After being thoroughly burnt, it should be pounded and sifted, and mixed with 1½ or 2 parts of sand. It must be thoroughly mixed with the sand while dry, and then moistened. "It will set in some degree in two or three hours, and become hard in a few days, after which it will continue still to harden, though slowly, for many months, or probably years." Some plastering, tried at the Cauvery Anicut by Captain (now Sir) A. T. Cotton, "became in a fortnight harder than any stone, except granite, marble, and stones of the first degree of hardness." Captain Cotton, in 1837, made a great variety of experiments with magnesia cement, using stone from various quarries, and with different proportions of sand, and other materials. Almost every one of them formed an excellent cement, setting generally in one or two hours sufficiently to be secure from the effects of water passing over it, but if plunged immediately in water, before it had begun to set, it would not set at all. It was observed by Captain Cotton that stone taken from the surface of the ground was all extremely hard, while in general that found below the surface was much softer, though apparently equally pure, but hardened by exposure to the air; the cements made with the under stone were not found to give such good results as when surface stone was used. A mixture of iron ore with the magnesia in equal parts, both finely pounded and sifted, was found to make the strongest cement, and a mixture of lime and ironstone with the magnesia was also found to form a very hard cement. In forming cubes of brickwork, the magnesia cement was found to set very rapidly, "and in a few months it became so hard that it was impossible to separate it from the bricks; however small the cube was broken up, the bricks were always broken, without the cement being separated from them." A mixture of lime makes the cement less liable to crack when used as a plaster, but it will not set so hard. In September, 1835, a committee was formed of engineer and medical officers at Madras, to examine a supply of calcined magnesia received from Salem, and to report on its fitness for building purposes. In their report it is stated as follows:

"The committee carefully examined portions of the magnesia cement on the walls of the superintending engineer's office, and on the sea face of the fort (in one of which, prepared from 3 parts, by measure, of sand, and 2 of the last supply of magnesia, salt was employed without injury), and find that they had acquired a great degree of hardness, although not fully equal to some specimens prepared from a former supply, which had been longer exposed to the air, and which had attained an extreme degree of hardness. It would appear, also, that a proportion of sand, amounting to about 1½ parts, by measure, to 1 of magnesia, increases the usefulness of the cement for general purposes, but that this proportion may be increased or diminished, according to the view with which it is employed. When applied as an hydraulic cement it should not be subjected to water for upwards of 12 hours from the time of its application."

Turning now to the "Roorkee Treatise on Civil Engineering," vol. i., page 70, we find that Major H. A. Brownlow, R.E., Superintendent Eastern Jumna Canal, in a case where some urgent repairs were required, made a most excellent cement from the stone lime and brown alluvial clay procured near the head of the canal, following General Pasley's rules for mixing and calcining. Hydraulic cement has also been made with considerable success in Madras and at Singapore. Lieutenant Morgan on the Eastern Coast Canal, six miles north of Madras, made cement of 7 measures of shell lime to 5 measures of clay, following closely Pasley's rules for mixing and burning it. If applied under water this cement hardened in 24 hours; if applied dry and water let on it in half an hour, it hardened in 8 or 10 hours. The same cement mixed with an equal quantity of soorkhee (pounded brick) hardened in 48 hours under water, or in 12 to 24 hours if allowed half an hour before the water was let on it. Captain Man, at Singapore, found he could make a similar hydraulic cement, of excellent quality, using 5 measures of slaked lime to 2 of fresh blue clay. Natural hydraulic lime may be made from all the kunkurs found in India, but they will of course be found to vary in character with the different proportions of clay found in their composition. It is a common practice in India to mix a small quantity of the coarsest sugar ("goor," or "jaghery," as it is termed in Madras) with the water used for working up mortar, and to this is attributed the fact that mortars made of calcined shells have stood the action of the weather for centuries, from their having this mixture of "jaghery" in their composition. Captain Man made experiments on bricks joined together by mortar consisting of 1 part common shell lime to 1½ sand. One pound of jaghery was mixed with each gallon of the water with which the mortar was mixed. The bricks were left for 13 years; and after that time the average breaking weight of the joint in 20 trials was 6½ lb. per square inch. In 21 specimens joined with the same mortar, but without jaghery, the breaking weight was 4½ lb. per square inch. In the jaghery mortars the cohesion and adhesion were nearly equal; in the other the former was nearly double the latter.

In Sir Proby Cautley's admirable work on the Ganges Canal, he has not omitted to record the nature of the cement used by him in that undertaking. Referring, then, to that publication for the desired information we find that in the construction of the Myapoor works, boulder masonry was laid with a cement composed of one part stone lime, one part soorkee, and one part sand, whilst with brick masonry the cement used was one part stone lime, and one part soorkee, and the whole of the works were stuccoed with a cement formed with the latter ingredients, and in the same proportions. In the Rutmoo works, which are built wholly of brick, the lime used in the cement was made from lime rock either burnt in the Dehra valley, or from lime boulders collected in the bed of the Ganges. The proportions of material used in cement were as follows:

Mortar		1 part stone lime 2 parts soorkee
Plaster	Inlet and dam piers	1 part stone lime 2 parts soorkee
	All the rest of the work	3 parts stone lime 2 parts soorkee

Similar statements occur in the various parts of the Ganges Canal Report, volume ii., and in the third volume is a statement of the entire amount of lime used on all the canal works. In some experiments made at Roorkee to discover the

best composition for an hydraulic cement, the bricks, the day after being joined, were placed at the bottom of the Ganges Canal, and exposed to a stream of nearly three miles an hour. The cements were made of old fat stone lime, which had been lying under a dry arch for six years since being burnt; this was slaked, mixed with 1½, 2, and 2½ times its own weight of ordinary brown clay, following Pasley's directions. The composition of 1 lime to 2 clay was found the best, and 1 lime to 2½ clay the worst. At the same time some fresh stone lime was groundand mixed up carefully with an equal bulk of ground soorkee; and the result of a number of experiments proved that although the mortar made of lime and soorkee set in the air as hard as that made of the lime and clay burnt together, yet it would in no case set when exposed to the force of the canal stream; while the cement after 14 days under water required a breaking weight of 10 lb. per square inch to separate the bricks. Some very hard blue clay was afterwards obtained from Hurdwar, and mixed with fresh stone lime, very slightly, if at all, hydraulic, in the proportion of 1 lime to 2 clay; and balls were calcined and ground as before; of this cement four prisms were made 6 in. × 2½ in. × 2½ in., and after 26 days immersed in water were subjected to a transverse strain, the bearing being 4 in. The average breaking weight of the prisms was 598.5 lb.; the greatest being 675.5 lb. This gives the value of C, the constant of strength for this cement = 153, while for prisms of Roman cement 11 days old it was only 150. The lime used in that part of India is derived from three sources; 1, boulder limestones found in the beds of hill torrents; 2, marl, or earth lime, as it is called; 3, kunkur lime. The following is an analysis of the first two varieties:

Nature of lime.	Moisture expelled at 212°	Organic matter and moisture.	Silicious matter and clay	Carbonate of lime.	Carbonate of magnesia.	Oxide of iron and alumina.	Total.
1. Marl lime	1.44	1.27	49.80	37.01	2.79	7.69	100
2. Stone lime ...	0.49	2.43	11.18	50.43	23.73	11.53	100

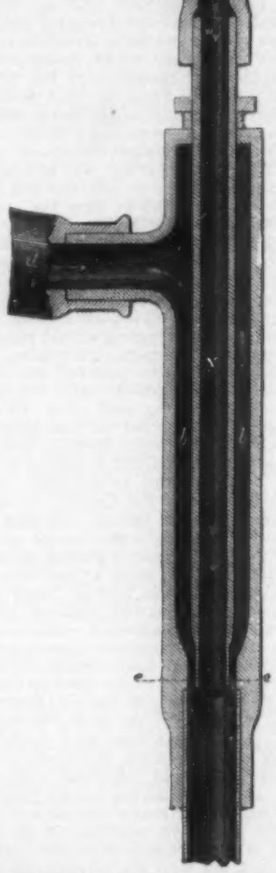
The kunkur lime is similar to No. 2, both differing widely from stone lime. All make excellent mortars for hydraulic works; the ordinary mixture with No. 1 lime being 1 part stone lime to 2 of soorkee, or 140 lb. lime to 400 lb. soorkee, and if the mortar is to be used for ordinary building, 1 lime, 1 soorkee, and 1 sand may be used. With the marl lime, 1 of lime to 1 of sand, without any soorkee, is used.

Part of the foregoing particulars is taken from vol. iv. of the "Professional Papers on Indian Engineering," published at Roorkee. At page 192 of the same volume we find an account of the process of manufacture of artificial hydraulic lime on the Kurrachee Harbour Works. "Ordinary rich lime slaked to powder, is mixed with clay, in the proportion of 5½ parts, by measure, of lime, to 1 part of clay. The rich lime used in the harbour works has been generally made from the hard crystalline limestone procured from the Giznee hills, near Kurrachee (shell-lime would probably be found a tolerable substitute where limestone is not easily available.) The clay is procured *in situ* from the bed of the Lyaree river, and is of the description that might be used for bricks or coarse pottery. The mixture of the lime and clay is made in a mortar pan worked by steam power, a sufficient quantity of water being added to bring it to the consistency of a stiff mortar. The mixture is then made by hand into balls of about the size of a large orange, which are laid out on the ground to dry in the sun. When thoroughly dried, which takes from two to six days, according to the weather, the balls are burned in a kiln: or if the lime is not likely to be soon required, they are stored in a shed. It is most important that the balls should be thoroughly dried before burning."

Volume v. of the same series of "Professional Papers," contains, at page 385, an account of experiments on mortar made by Lieutenant J. L. L. Morant, of the Royal (Madras) Engineers, during the construction of the masonry forts in Bombay Harbour. We have already stated enough to show that information does already exist, in an available form, as regard the limes, mortars, and cements of India; it will not therefore be necessary to follow out these experiments here. The fact is—not that the information recently called for by the Indian Government is wanted; but rather the means of enforcing more vigilance in the inspection of materials obtained by contract for building purposes, so that fraud and adulteration may be certain of detection and punishment; that incapacity in the executive may meet with its proper reward; and that neglect of duty may not be practised with impunity.

THE SAND BLAST.

At the fair of the American Institute at New York, recently closed, there was exhibited the apparatus which has made considerable sensation in the States during the last year, and known as Tilghman's sand blast. The perfect simplicity of the contrivance is no less remarkable than the extraordinary results obtained by it. Its object is to drill, cut, or grind hard substances, such as granite, metal, or glass, and its action depends upon the expulsion, at a considerable velocity of quartz-sand by a steam or air jet passing through a tube, and striking the material operated on. The accompanying sketch will clearly explain the construction of the apparatus. The sand is fed from an elevated box through a flexible pipe, *a*, which is kept at an angle of about 45° to regulate the flow of the sand. Passing down through the tube, *c*, which terminates in a nozzle, as shown, and is enclosed in an outer cylindrical casing, forming an annular space, the



sand encounters the steam or air which is admitted into the flexible tube, *d*, and forms at *e* an annular steam jet, by the aid of which the sand is driven forcibly through the directing pipe, against the object to be operated on. To provide a regular reciprocating motion of the jet over the surface of the material, a mangle rack movement is employed, by which the feed can be regulated, and the blast concentrated at will. In some early experiments made with this apparatus, a hole, 1¼ in. diameter, and 1½ in. deep, was drilled through a block of corundum in 25 minutes, with a pressure of steam of 300 lb. Again, with 100 lb. pressure, a hole, 1 in. by ¼ in., and ¼ in. thick was cut through a hard steel file in 10 minutes. And, at the American fair the other day, a diamond was sensibly reduced in weight in one minute, and a topaz was entirely destroyed. These and many other experiments are good tests of the capabilities of the apparatus, but the most interesting results are those which have an obvious commercial value. It is a very curious feature of the invention that, whilst hard substances are thus rapidly affected, soft and delicate materials are left untouched when exposed to the same influence. Thus, if a thin stencil sheet of india-rubber be laid over a block of granite or marble, and the blast turned upon it, the stone is cut or drilled, while the rubber remains untouched. Again, if a photographic film of bichromatised gelatine be placed on a sheet of glass, and the jet applied, a picture may be engraved, and in the same manner flowers and fern-leaves may be reproduced with the utmost delicacy.

For grinding glass a very slight pressure is sufficient, that produced by air under 4 in. of water being ample for the purpose.

The uniform success which has attended the use of the sand blast has sufficiently proved its reliability, and the numerous purposes to which it can be applied, promises to render it one of the most useful inventions that have been of late brought into public notice. By simple modifications it can be made to supersede the present slow and costly process for shaping granite and other hard stones, for rock drilling, and for polishing castings, or grinding and engraving glass. The cost of working it is of course extremely small, and there need be no loss of the sand employed, as it can be constantly restored to the feeding hopper, together with the particles driven from the material.

The action of the sand upon a hard surface appears to be due to the work performed by each angular particle that strikes, and which in striking carries away with it a particle, of course far smaller than itself, and the reason why the softer materials resist the wearing action is due to their elasticity, which repels the particles. As a further proof of this, it may be mentioned that while perforated shield plates of lace, gelatine, or rubber bear a prolonged exposure to the sand unharmed, stencils of thin sheet steel or brass speedily curl up, and are destroyed.

EXPRESS LAUNCHES.

Building steam launches for river and for harbour service, has of late years developed itself into a considerable and a profitable trade. Several engineers have devoted themselves exclusively to the construction of such boats, the demand for which is not to be judged of by the small steam craft running up and down the Thames, and which on boat-race days, and other aquatic holidays, hover round in such astonishing numbers. Messrs. Yarrow and Hedley, for example, export a large number of such launches to Australia, South America, and elsewhere, and every one knows White's smart screw boats built at Cowes. But no builder has begun to compete with Mr. J. I. Thorneycroft, of Church Wharf, Chiswick, whose fast launches are now becoming familiar to the frequenters of the Thames, and who has certainly produced the fleetest boats of this class since it has come into fashion.

Church Wharf, Chiswick is but a small place, with the sloping river bank thickly crusted with sewage deposit—a present from Barking—with a miniature building yard, fitting and erecting shops, and offices, in front of the quaint old church with the square tower, where amongst other worthies of a past century Hogarth rests.

In the yard are several launches, an old one that has seen good service laid up for repair, the Miranda, drawings and a description of which we published on the 3rd of November last, and some more in course of construction. Afloat is the Canopus, a very handsome launch just completed for Mr. John Fowler, and still wanting her cabins, and some of her fittings. The Canopus is a boat very similar to the Miranda, but 3 ft. longer, being 53 ft. long, and 6 ft. 6 in. beam. The hull, like that of the Miranda, is of Bessemer steel plates, with a framing of steel angle irons. Although she looks built essentially for speed she is very roomy, and able to carry 30 persons with ease. The boiler and engine are, as in nearly all of Mr. Thorneycroft's boats, placed amidships, leaving ample space for good fore and aft cabins, while at the same time there is plenty of room for the machinery, and the driver and fireman. The boat can be steered, either with a tiller, or by lines carried to the deck which covers the boiler. The latter is as usual of the locomotive type, and is the only part of the launch not produced at the wharf. It was made by Messrs. Hicks and Co., of

Bolton, of Bessemer steel, with a working pressure of 140 lb., and with 136 ft. of heating surface. The engines, placed about 5 ft. aft of the boiler, are exactly similar to those illustrated by us on November 3. The cylinders are 6 in. diameter, and 8 in. stroke. The moving parts are all of steel, thoroughly well proportioned, and of first-class workmanship. The engines are, of course, direct-acting, and the screw shaft runs out well clear of the rudder, which is divided so as to clear it, as shown in the drawing before referred to. The blades of the screw, which are keyed into the wrought-iron boss, are ground to a sharp edge, so as to shear off weeds and other impediments that may hamper it—a very useful arrangement in running upon water where vegetation is luxuriant, and sufficiently strong to draw a small boat under water, if the screw becomes entangled and is not stopped promptly.

The Miranda gave excellent results in running, often making 18.4 miles an hour in dead water. But the Canopus, with increased boiler power, has surpassed her, although the latter would have some difficulty in beating her on a short course. The Canopus was guaranteed to have a speed of 15 miles per hour, but she has on several trials exceeded 18.60 miles.

On a recent occasion the following experiments were made, which give a fair idea of her performance. It should be premised that there was no wind, but that the condition of the river was extremely bad, the flowing tide bringing with it water heavily charged with mud, weeds, branches, and general débris, which not a little interfered with the speed of the boat.

Starting from Chiswick, the Canopus made four trips to and fro on a measured mile, the upper terminal point of which was the lower face of Barnes Railway Bridge. The whole time occupied in running the four miles was 12 minutes 54 seconds, giving an average of 3 minutes 13.5 seconds per trip, equivalent to an average constant speed, with and against the tide, of 18.60 miles per hour. On averaging the speed made during each trip, the amount is, of course, somewhat changed, but the rate given above is the true sustained speed.

1st Run.	Time,	2	min.	38	sec.	= 22.78	miles per hour.
2nd "	"	3	"	36	"	= 16.66	" "
3rd "	"	3	"	3	"	= 19.67	" "
4th "	"	3	"	37	"	= 16.59	" "

The average of these speeds is 18.925 miles per hour. The longer times and slower speeds indicate the direction of the tide, which on the third trip had comparatively small influence. The steam pressure in boiler was well maintained, sinking from 120 lb. to 115 lb. in the first trip, and to 110 lb. during the second, but keeping well up 120 lb. for the two final runs.

A somewhat singular phenomenon is developed by the Canopus and others of her class during high speed runs. When passing through the water at a moderate velocity, the vibrations of the boat, with its light elastic framing and thin skin, are very marked, but as the speed rises, the vibrations decrease, until the maximum speed is reached, when they are changed into a slight tremor, continuous, but somewhat variable. The boat lifts, too, until her keel is almost visible at the bow, while the stern rises also, and the following wave is very sensibly reduced. This apparent or actual lessening of displacement, reduction of vibration, and of commotion in the water, would seem to depend upon the same cause, the attainment of maximum speed.

Certainly no steam launches have ever before given such results as those we have been describing. The great floating side-wheel palaces on the Hudson river make, it is true, much higher regular duties. Thus the Daniel Drew, one of the finest boats plying between New York and Albany, 145 miles, has often made the run in 6.50 hours upstream, being a speed of 21.25 miles per hour, the same boat, with the tide, showing a performance of 25 miles. Again, the New World, the Allida, and the Armenia boats, built and running on the same course ten or twelve years since, made a regular time of 7.25 hours, and the Francis Skiddy 15 minutes less. Still earlier, in 1848, the Oregon made double runs on the North river 40 miles each way, with and against the stream, in 3 h. 13½ min., being 24.7 miles per hour.

In this country, too, not to quote later examples, the Ruby and the Neptune, rival boats—one built by Henderson, the other by Napier—maintained a speed of 21.6 and 20.059 miles respectively, during a prolonged trip, whilst the Holybead and Kingston boats average 16.7 statute miles regular working.

But all these are large boats, filled with power, and very different from the small Canopus, with her nominal 8 horse engines, working at some 550 revolutions per minute, and developing over 60 horse power, to drive her through the water.

STEAM BOILER TRIALS.

DURING the recent fair of the American Institute, at New York, there was carried out a very interesting trial of the steam boilers exhibited, this trial being conducted by a method which, although often proposed, has seldom—and we believe never so completely—before been put into practice. The boilers on exhibition were the Root boiler—called here the "safe and sure" steam boiler—the Allen boiler, designed by Mr. Charles T. Porter and the inventor of the Allen engine, of the same class as the preceding, but very different in construction, the Phleger boiler with tubular water grates, the Don and the Blanchard boilers, both being peculiar modifications of the ordinary forms of tubular boiler.

It was evident that the ordinary method of trial would not be a real test of the respective economical values of boilers so entirely different in construction and arrangement, and the Committee of Judges, appointed to report in that department, declined to report definitely except after a trial that should accurately determine how much water each boiler could evaporate, and how much each threw off unevaporated per pound of fuel consumed.

With commendable liberality the Board of Managers agreed to the proposal of their Committee, and, under the direction of Professor Thurston, of the Stevens Institute of Technology, chairman of the Committee, the necessary preparations were made.

A surface condenser was prepared by placing in a large wooden tank about 1100 ft. of 4 in. gas pipe. Meters were attached to the boiler feed-pipe and to the injection pipe, a scale was fitted up to weigh the water of condensation, a pyrometer was used to take the temperature of the escaping gases in the chimney, "as nearly as possible 4 ft. from the nearest heating surface," and thermometers were arranged to give the temperature of feed and injection water, the water of condensation, the discharge water from the tank, the steam in the boiler, and the temperature of the external air. Readings of the barometer were recorded, as were all the above quantities and the weight of fuel, every half hour during the trial. By means of a screw stop valve in the steam pipe the steam was kept as nearly as possible at a pressure of 75 lb. per square inch above the atmosphere, and through this valve the steam passed into the condenser.

Knowing the quantity of heat transferred from the boiler to the condenser, and the weight of water by which that heat was transferred, it becomes a very simple matter to determine the amount of heat transferred by each pound of the water of condensation, and from that the state of the steam. An excess of heat over that which would be transferred by saturated steam indicates superheating, and a deficiency of heat proves some of the water to have come over from the boiler unevaporated, and the relative amount of water evaporated and unevaporated are calculated by a simple algebraic operation.

It is expected that the report of the Committee will soon be made public, and we shall give a summary of its results. It is said that all the boilers under test gave excellent results, being equivalent in every case to not far from 10 pounds of actual evaporation from a temperature of 212° Fahr. for each pound of fuel.

The Committee of Judges consists of Professor R. H. Thurston, Messrs. T. G. Sloan, and Robert Weir. The readings were taken, and the log kept by selected students of the Stevens Institute of Technology, Hoboken, New Jersey, and are probably very accurate and reliable. The amount of condensing water was about 10 tons per hour, and its temperature was raised from 45° to about 150° or 160°. The amount of water of condensation was from 1 to 1½ tons per hour. The boilers were of about 30 square feet of grate surface, and about 900 square feet of heating surface. Precise figures will be given in the report.

IRON FOR MONTE VIDEO.—The Blaenavon Iron Company has shipped 315 tons of iron for Monte Video by the Herbert Graham.

PAVING IN THE UNITED STATES.

ALL over the world great interest appears to be excited just now in the question of street paving, and the contagion has even spread to the United States. A few details in illustration of the arrangements adopted in some of the American cities will not be out of place, under these circumstances. It appears that Pittsburg, Pennsylvania, was originally paved with cobble stones on a foundation of river sand and gravel. A large amount of travel and heavy hauling has left the streets in a bad condition, uncomfortable for business purposes, and detrimental to the general interests of the city. During the past five years a number of streets have been paved with the original Nicholson pavement; and these streets are still in good condition, although there are indications in some localities of the wear and tear to be expected. Second, Fifth, Sixth, and Penn avenues were recently examined by a Committee of the Philadelphia Common Council; and the general sentiment among those consulted by the Committee appeared to be that a wooden pavement enhances the value of property and is preferable for comfort and business purposes. The principal streets of Columbus, Ohio, are laid with the Nicholson pavement, 3½ miles having been put down since 1866. White pine was used without regard to sap, with 1 in. lining strips on a foundation of 4 in. of gravel, rolled and covered with tarred pine boards, upon which the paving blocks were placed. Prior to the paving, the gas and water attachments were provided to the curb line for all houses and open lots, thus avoiding the serious complaints and difficulties arising from want of such a provision. The cost of intersections was charged exclusively to the property frontage, the only charge from general taxation being for the grading of the streets, which is done at an average expense of 75 cents per cubic yard. The cost of laying the Nicholson pavement was on an average about 2 dols. 14 cents per square yard. The general opinion of the authorities and others is that no wooden pavements will last longer than seven years, and would not average good longer than five years. Many of the wooden pavements in Columbus already present an uneven and depressed surface.

Chicago has—or perhaps rather had before the great conflagration—400 miles of streets generally of greater width than those of Philadelphia. Of the Chicago streets, 90 miles are paved, 70 miles being laid down with wooden pavement of the Nicholson or improved kind. It has been demonstrated—or believed to have been demonstrated—at Chicago that the use of tar is no preservative of wood; and a considerable extent of paving has been put down without it with an opening of 1 in. between the blocks filled in with a concrete of sand and gravel. The general opinion of the officers of public works and of the people generally is that five years is as long a period as a wooden pavement will remain in a good condition; but where cost is a secondary consideration, and a renewal of way can be accomplished every five or seven years, a noiseless wood pavement is unexceptionable and preferable. The Chicago Board of Public Works is putting down as an experiment in some of the streets formerly laid with Nicholson pavement the De Golyear No. 2 patent wood pavement. The principal advantage of this pavement appears to be the use of wood prepared under the Samuels process of ironising. It is claimed that wood prepared by this process is impervious to wet and dry rot, and the attacks of worms and insects, and that when used for paving it is only subject to the effects of use or travel. The patentees also contend that their process gives a greater tenacity to wood, with comparatively no absorption of moisture. The cost of wood pavements in Chicago has hitherto been from 1.50 dols. to 1.60 dols. per square yard. The cost of wood-paved streets 45 ft. wide from curb to curb, including repairs for ten years, is estimated at 4 dols. per linear foot. Chicago being the great lumber mart of the West, with white pine selling at the rate of 14 dols. to 15 dols. per 1000 ft., furnishes facilities for wooden pavement at about half the cost at which the corresponding work could be executed in Philadelphia and other parts of the United States. Notwithstanding this local advantage in favour of Chicago, Chicago officials, engineers, and residents appear to express a preference for a good class of Belgian pavement, solely on account of its greater durability. The streets of Cleveland, Ohio, were formerly paved with a class of rubble on the Belgian system, but

not strictly so, there being more space than usual between the courses of stone blocks. Many streets in Cleveland paved in this manner ten or more years since are now in good condition, with evidences, however, of wear, as was to be expected. It is estimated by the mayor and chief engineer of Cleveland, that 10 miles of wooden pavement have been laid in the city; all of this mileage, with a small exception, is on the Nicholson system. Wooden pavement, however, is stated to have proved a failure in Cleveland, although it has not been put down more than five years. The authorities of Cleveland—who seem to be more difficult to please than their neighbours—tested the merits of the De Golyear No. 3 pavement, prepared on the Samuels plan of ironising, and they state that they found that it did absorb moisture; they accordingly place no confidence in it. They are now paving a few squares with wood saturated with rosin. The cost is 2 dols. 55 cents per square yard; and the city engineer states that he has more confidence in this plan than in any other which has been tested. The experience of Cleveland as to wooden pavements is the same as that of other towns. Although wood pavements are pleasant and agreeable, both in appearance and in the prevention of noise, the verdict of Cleveland is against them, whether they are prepared or not; at any rate, the verdict is against them when a good quality of stone can be procured. The contractor who put down wooden pavements in Chicago, St. Louis, and other Western American cities, admitted to the Philadelphia committee that all of them had, to some extent, proved a failure; he was, however, under the impression that wood prepared with rosin would perpetuate the use of this class of pavement.

EGYPTIAN RAILWAYS.

(*Concluded from page 378.*)

M. Delorme, in considering the road to reform, points out that the first step required is in a total change of the system of administration. It is necessary, he says, to introduce a clear distinction between the administrative service and the traffic management, the permanent way superintendence and the locomotive and rolling stock direction, that the head of these various departments should be competent, honest, and zealous, and that each should be accountable to the Central Bureau. In the present state of things neither the permanent way, the rolling stock, nor the traffic are managed properly. The traffic manager looks after the locomotives, the locomotive superintendent looks after nothing particular, and the permanent way inspector looks after what does not concern him. As an illustration of the present state of the administration it may be mentioned that a rule exists, passed apparently to save work at the Central Bureau, that the railway employés are not to be paid at their various stations, but that they must report themselves to the central office for their salaries. From this arises a continual coming and going upon the lines, and a constant commotion in the service. And it is not an uncommon thing to see engines making the trip from Alexandria to Cairo solely for the purpose of conveying drivers and firemen to where they may obtain their pay.

One of the most necessary reforms would be the establishment of a Commission, which should investigate the question of engine and carriage repairs, maintenance, &c., the causes of accidents, and other matters. It is true there exists a so-called Railway Commission, but this Commission is true to national characteristics. Not only does it ignore matters connected with the management of railways in general, but it preserves itself carefully from studying Egyptian railways in particular; all is left to chance, or to the grace of God; and, even if the Commission was capable, the want of compatibility amongst its members would render it practically useless.

Amongst other officers there exists a dignitary known as inspector-general, but who in justice should be designated cicerone to distinguished visitors. Besides this, the duties of this individual have never been clearly defined. Sometimes he presides at committees, sometimes forms a member of the Commission, sometimes he scours Europe for mechanics, and again, occasionally, he tries to investigate the causes of accidents without success.

In this way does M. Delorme criticise the existing condition of matters administrative, and doubtless there is much justice in his remarks; the condition of things is deplorable, but there exists real cause for wonder that it is not worse.

As is the administration of the works, so are the works themselves; as is the management of the traffic, so is the road upon which the traffic is conveyed. From want of proper maintenance, accidents are common; trains quit the rails, and locomotives and rolling stock are damaged and destroyed rapidly. Signals are wanting where they are most required, the number of employés is reduced for economy's sake, whence arise collisions, to the risk of life and property, and the serious loss of rolling stock. The pointsmen, it is alleged, intent on their favourite occupation of doing nothing, or of spinning wool in their rude fashion, disregard the approach of trains, and often attempt to change the points when the engine or part of the train has passed.

M. Delorme assures us, speaking of the locomotive and rolling stock mismanagement, that it is difficult to point out the disorder and indifference that exist; the ideas that appear paramount are to permit engines to run at their own pleasure, to burn as much fuel, and to destroy as much stock as possible. Engines ready to start sometimes are kept standing for twenty-four hours under steam, waiting for the trains they are to draw to be made up. The signalmen have the crudest notion of their duties, and one sees on the arrival of trains after dark, white, red, and green lights flashed with embarrassing profusion, due to the doubts of the employé who, uncertain which should be displayed, shows all. The trains travel with a regular irregularity, and the hours of arrival and departure are as uncertain as the speed achieved. The lighting of the carriages and the lubrication of the axle boxes is miserably imperfect, owing—whisper rumours—to the artificial taste for oil acquired by the railway servants. Trains of empty wagons circulate purposelessly, and no care is taken in loading merchandise, so that while one wagon is loaded far beyond its capacity, its neighbour, which ought to have carried part of the weight, does nothing. It is asserted that there was once a time when an arrangement was entered into between some of the employés to have the passengers' tickets printed in England on their own special account. Of course, after a time this proceeding was discovered and stopped; probably on no other railway system in the world would this corruption have been possible.

The number of locomotives owned by the Egyptian railways is 240, a larger quantity than is required, judging from the fact that only 100 engines drivers are employed. The following Table gives the particulars of the locomotives furnished up to 1869:

Name of Maker.	No. of engines.	When supplied.	Average days in use, 1869	Cost.
		between		£
Stephenson, Newcastle	52	1852 and 1866	196	3800
	32	1867 „ 1868	244	
Sharp, Stewart, Manchester	25	1855 „ 1865	183	3500
Kitson, Leeds	15	1865 „ 1866	231	4130
Beyer, Peacock, Manchester	12	1857 „ 1865	212	3600
Schneider, Creusot	20	1864 „ 1865	220	3290
Kœchlin, Mulhouse ...	9	1864 „ 1865	262	3317
Cail, Paris	7	1859 „ 1864	331	3000
Cockerill, Seraing	16	1865 „ 1866	230	3400

This list includes an almost endless variety of types, due partly to the activity displayed by the Egyptian authorities in giving orders to the various makers to build from such of the numerous patterns exhibited in the exhibition of 1862 as struck their fancy. Thus at the Boulak depôt, one may find 8 different passenger engines, 14 classes of mixed engines, and 23 varieties of goods engines, besides a number of different patterns of special locomotives. Needless to say that such a collection involves endless complications and expense in repairs and renewals, and that it is totally opposed to any kind of economy. Repairs, moreover, are extremely costly, independent of the fact that reckless usage and carelessness consigns engines to the scrap heap before they have performed any adequate duty. The cost of repairs, indeed, have often been so great that it has been found cheaper to purchase new engines than to maintain existing ones. To take one example, the prices paid for some renewals on one of the locomotives:

	£
Copper firebox	512
646 stays	119
200 tubes	465
2 cylinders	221

Possibly it was on account of high charges such as this, that under one administration 44 engines were condemned *en masse*, and 50 new ones ordered to take their places; an order which was not given, however, under the careful rule of Ismail Bey, who passed instructions that every locomotive boiler should, independent of the amount of work it had performed, be submitted every six months to the test of hydraulic pressure, and that after each test, a record of which should be stamped upon the engine, the working pressure should be reduced at least 15 lb.

The rolling stock of the Egyptian railways consisted in 1870 of 4498 wagons, representing a capital of 1,200,000*l*. This stock may be divided as follows:

Railway wagons	65
Gun „	77
Ballast „	114
Cotton „	410
Corn „	200
General „	524
Covered „	834
Coal „	1246
Post Cars	20
Miscellaneous	866
German 2nd and 3rd class carriages ...	87
American 3rd class carriages	54
3rd class or linary „	49
2nd „ „ „	89
1st „ „ „	54
State cars	2
Ditto	7
Total	4498

It is almost superfluous to say that the repair and maintenance of rolling stock are carried on in a manner equally extravagant with that of the locomotives. About 1000 wagons come into the shops at Alexandria or Cairo monthly for repair, and work done in the one establishment is often undone at the other. The absence of capacity on the part of the local employés, also, renders it imperative that the vehicles should be despatched to the chief shops even for the most trifling requirements. The carelessness practised in handling them, the deficiency in their fittings, faulty buffers, ill-assorted couplings, coverless axle boxes, and so forth, are lively causes of damage, whilst their condition reacts upon the merchandise they carry, which is often damaged in transit. Moreover from the want of system it results that loaded wagons are often left neglected and exposed to the no small detriment of the vehicles and their contents.

Such are some of the characteristics of Egyptian railways as described by a French engineer, for as we said, we have drawn largely from the information he has collected. But it must be remembered that despite all the corruption, indifference, and ignorance, which have formed an inherent part of the Egyptian railway system, and which have been sufficient, not only to prevent progress, but to destroy what individual energy and determination have effected in that country, that French engineers have a special grievance against the Khedive, because he has shown a marked preference for aid from England and for English professional skill. That English agents have from time to time in the past reaped unholy benefits from the country where all lay ready to their hands, there can be no doubt; but if we mistake not, France has been far more guilty in this respect, and the consideration that these opportunities have vanished, may probably act as a powerful inducement—we do not hint at M. Delorme—for French disparagement. We shall again refer to this question of Egyptian railways, and of Egyptian works generally, which are likely to be of far more interest than formerly, now that the engineering matters of that country are placed in good hands, and reform is imminent with all its practical and moral benefits.

THE DOVER AND RAMSGATE TRAMWAY.

The most cursory examination of the plans lately deposited at the Private Bill Office discloses the fact that amongst them are a great many tramway schemes. Looking at these latter by themselves we at once see that the provinces are receiving their share of attention in this respect. Of the 46 tramway projects which will probably have to be dealt with next Session, 5 only are metropolitan and suburban schemes, whilst the remaining 41 relate to country towns. Amongst the latter is one which we single out from the rest for notice, because it embodies several special features which render it distinctive from existing lines. This is the Dover, Deal, Sandwich, and Ramsgate Tramway, and its specialities are that it is proposed to construct it on turnpike roads for the purpose of connecting distant towns—an object never before attempted in this country—and that it is intended to carry merchandise as well as passengers over it. The necessity for a more direct and fre-

quent means of communication than at present exists between Dover and Deal—which are 9 miles apart—has long been felt. There are, it is true, coaches running between the two towns, but they are found at times to be inadequate for the purpose, whilst the journey by rail between these two points is about 60 miles, and involves a run to Ashford or Canterbury. From Deal the line will be continued to Ramsgate through Sandwich, and will thus open up a new district. Upon the score of local convenience, therefore, the proposed tramway appears desirable. With regard to the engineering features of the route there do not appear to be any difficulties, if we except a short piece of steep road by Dover Castle. As, however, the daily traffic is carried on under ordinary conditions of care and skidding the wheels in descending the incline, there can be no difficulty in running tram cars in which all the wheels can be locked if necessary, thus giving much additional brake power.

The construction of both tramway and cars will involve several points of interest, as neither will be built upon the rule of thumb principle so often seen in similar works. The rails will be of a single-headed section — specially designed of course to suit the present application and the requirements of the Board of Trade—and bedded in concrete and asphalte, so arranged as to form a sound tramway, and at the same time to preserve a good roadway for ordinary traffic. The carriages will have a much longer wheel base than is at present given to them, whilst to enable them to turn sharp curves they will be jointed on an improved principle. The wheels will be coned and flanged similarly to railway wheels, and will run loosely upon fixed axles. Such is an outline of the scheme and of its constructive points. The details of course are not yet fully worked out, but when the designs are completed we may have something more to say of them. The promoters are evidently striking out a path for themselves, and at least deserve credit for their intentions to carry out a reasonable scheme on principles which are calculated to meet many objections to be found in existing tramways. It is of course to be worked by horses, but will very probably before a remote date be turned into a steam-worked line, which would be much more satisfactory. As this line would act as a feeder to the London, Chatham, and Dover and the South-Eastern Railways, it will doubtless prove to the interest of those companies to give their support to the scheme, to which we understand they are by no means opposed.

NOTES FROM THE SOUTH-WEST.

The Building Trades.—The building trades at Swindon are agitating for the nine hours' movement. The masters met on Friday evening, and decided that in the present state of trade, they ought not to be asked to give up an hour per day. They, however, expressed their willingness to pay the men by the hour, so that the length of a day's work would be optional.

Great Western Railway Employés.—There has been a meeting of Great Western Railway employés at Neath to consider their present position and hours of labour. The meeting resolved to make the following requests to the directors: 1. That ten hours be considered a day's work, and that 60 hours constitute a week. 2. That at the end of a week it shall be considered a week's work, so that no calculation shall be made from the hours of one week into another. 3. That all hours above 60 in one week shall be paid as overtime at the rate of eight hours per day. 4. That our Sunday duty be reduced as much as the business of the company will admit; but should a man be required to work a seventh day on Sunday, he shall be paid time and a half for it. 5. That weekly payments be substituted for fortnightly ones. 6. That a book be provided for each man to sign when commencing duty, and likewise when he has disposed of his train, and made out his returns. 7. That for men in charge of points, signals, and telegraphs, nine hours be considered a fair day's work, and that 54 hours constitute a week's work.

The Forest of Dean.—Great activity prevails in the Forest of Dean district. There has scarcely ever been so good a demand for all descriptions of coal, and prices have improved. There has been no falling off in the demand for Forest pig iron, and even with the present quotations orders can scarcely be kept under. It is anticipated that a further advance in prices will be obtained at the close of the year. The agitation among the colliers has now been extended to the iron workers and engineers.

Iron for the United States.—The Nebo has cleared from Newport for New Orleans with 610 tons of iron supplied by the Nantyglo and Blaina Iron Company. The Lothair has cleared from Cardiff for New Orleans with 992 tons of railway iron supplied by the Rhymney Iron Company. The Embla has cleared from Cardiff for New Orleans with 586 tons of railway iron supplied by Messrs. Guest and Co. The Elizabeth has cleared from Cardiff for Galveston with 530 tons of railway iron supplied by the Aberdare Iron Company. The Argo has cleared from Newport for New York with 440 tons of iron supplied by the Blaenavon Iron Company. The Ydun has cleared from Cardiff for New Orleans with 800 tons of railway iron supplied by Messrs. Guest and Co.

Swansea Harbour Trust.—The monthly meeting of the Swansea Harbour Trustees was held on Monday. The finance committee reported that the revenue of the port had increased during the past five months to the extent of 1700*l.*, as compared with the corresponding period of 1870. The debentures of the trust are being easily renewed or replaced as they fall due.

Coal and Iron Exports from Newport.—The quantity of coal exported from Newport in November to foreign ports was 38,510 tons. The following ports each took more than 2000 tons: Barcelona, 2923 tons; Genoa, 3948 tons; Jamaica, 2642 tons; St. Thomas, 3061 tons. The exports of coal coastwise during the month amounted to 71,791 tons. The railway iron exports of the month were 7688 tons, of which 1930 tons went to Baltimore, 1354 tons to Mollendo, 1862 tons to New York, and 1297 tons to New Orleans.

Trade at Cardiff.—Trade continues active at Cardiff. The steam coal merchants have advanced their prices about 6d. per ton. An excellent demand is also experienced for house coal.

Pembroke Dock.—Another batch of massive iron armour-plates, some of them weighing 14 tons each, have arrived at Pembroke dockyard for the turret ship Thunderer. It is expected that the Thunderer will be so far completed by next March as to admit of her being launched. She will be one of the most ponderous ironclads in the world.

Trade at Merthyr.—Nothing can be better than the present condition of trade at Merthyr. The coal trade is in a flourishing condition, and the iron works are doing a large stroke of business. Some heavy orders have been just commenced.

Severn and Wye Railway.—Favourable weather has enabled the contractors for the new branches on the Severn and Wye Railway to prosecute their operations. It is expected that a tunnel at Mosier will be ready for the passage of trains early next year.

Pontypool.—The Ebbw Vale Company seems determined to infuse renewed energy into its works at Pontypool. The Lower Mill, only part of which has been used hitherto, is to be put into full operation; and at the Race, the furnace No. 3 is being re-built. The Pontypool Iron and Tin-Plate Company is also pushing on its operations with vigour. A locomotive built for the company, and named the Pontypool, arrived on Saturday; and a bridge over the Afon Llwyd, leading from the town to Trevethen Church, is being altered to admit of the engine and trains passing under the blind arch. There are threats of a strike among the local colliers, and coal has been advanced in consequence 6d. per ton to the consumer. With the exception of this circumstance, the aspect of business at Pontypool is encouraging.

Iron for Alexandria.—The Carolina screw steamer, has cleared from Cardiff for Alexandria with 1000 tons of bar iron supplied by the Aberdare Iron Company.

The Dock Question at Bristol.—Two commissioners, Messrs. Stephenson and Ball, appointed by the Board of Trade to investigate the prospects, engineering and financial, of rival schemes for ocean docks at Bristol, viz., the Avonmouth and the Portishead, have visited that city. Yesterday week, in company with the respective engineers, they went over the sites and works of both undertakings in the inspection of which they spent some hours.

Dauntsey and Malmesbury Railway.—A railway is proposed between Dauntsey and Malmesbury. The proposed line is supported by Mr. Sotheron Estcourt, Colonel Miles, Mr. Powell, M.P., &c. The estimated cost is 60,000*l.*, and the Great Western Company will subscribe half the capital, guarantee 2½ per cent. on the local capital, and work the line at 50 per cent. of the gross receipts.

Bristol Wagon Works Company (Limited.)—The directors of this company have declared an interim dividend at the rate of 5 per cent. per annum for the half-year ending September 30. The dividend is payable, December 21.

Welsh Railways.—Notice has been given of an intended application to Parliament for powers to abandon the Aberdare and Central Wales Junction Railway. It was originally thought that the London and North-Western Company would have supported the project in order to obtain more direct access to the upper portion of the Aberdare and Rhondda valleys, but this expectation has been disappointed.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Midland Institute of Engineers.—On Wednesday last the monthly meeting of the Midland Institute of Engineers, under which head are included all the mining engineers in Yorkshire and most of Derbyshire, was held at Barnsley, in the rooms of the Institute, Mr. Hodgson presiding. There was a very good attendance. Mr. Mills (Messrs. J. Mills and Sons) of Newcastle-on-Tyne, read an interesting and able paper on "Craig and Bidder's Patent Magnetic Lock for Safety Lamps." The writer showed that all previous inventions had hitherto failed in preventing the miners and other persons working in collieries from opening their lamps with forged keys and various implements. The very numerous and serious explosions which have occurred through lamps having been tampered with, said Mr. Mills, fully demonstrated the great need for a lamp which could not be opened except by proper persons. He then explained the construction of the magnetic lock, which is in use at the Newcastle and Woodshutts Collieries, Staffordshire. The lamps are self-locking by being screwed round and cannot be opened without the aid of a powerful magnet, which weighs about a quarter of a hundredweight, its cost being 4*l.* 15*s.*, including frame. The locking principle can be adapted to lamps at the cost of about 1*s.* per lamp. The paper was ordered to be printed by the Society, together with the diagrams.

Coal Traffic; Yorkshire and Derbyshire to London.—All the collieries in South Yorkshire and in Derbyshire are at present experiencing a period of great prosperity, and although they are producing as much as possible, the demand is difficult to keep up with. The quantity of coal sent to London last month was the largest ever sent in any single month. The Midland greatly exceeds its previous monthly tonnage, but there is a marked falling off on the Great Northern and London and North-Western routes. The falling off by the Great Northern is 7168 tons, chiefly brought about by the fact of six South Yorkshire pits who work the Silkstone seam having forwarded 4726 tons less to London than they sent in October. The quantity of Barnsley seam coal sent in November is about the same as in October, ten of the principal collieries having sent but 187 tons more. As usual the Derbyshire and Nottinghamshire pits sent an immense quantity to London during the month, viz., Clay Cross, 33,815; Eckinton, 10,006; Codnor Park, 5008; Longley, 14,488; Sheepbridge, 9792; Staveley, 6580; and Pilsley, 6619 tons. These figures prove that trade is exceptionally good, especially for the metropolis.

New Furnaces in North Lincolnshire.—The number of furnaces in North Lincolnshire is increasing very rapidly. The Frodingham Iron Company, Frodingham, have just started a new oven, and Messrs Dawes and Co., of Elsecar (South Yorkshire) and Frodingham, are building four in addition to their three old ones. Other extensive additions are in contemplation in this district, and as the field is exceedingly extensive, we may confidently anticipate that Grimsby will become a sort of second Middlesbrough.

Abandonment of Proposed New Works near Sheffield.—It is announced that Messrs. Cammell, Wilson, and Co., who proposed to erect large iron works at Heeley, near Sheffield, have abandoned the idea of erecting them there.

Leeds Sewage Works at Knostrop.—On Wednesday the mayor of Leeds and about forty members of the Town Council visited the works at Knostrop to inspect the A. B. C. process of dealing with the town sewage. The outfall is at the rate of 12,000,000 gallons each 24 hours, about a sixth of which, or 2,000,000 gallons, is diverted from the main stream to be operated upon under the A. B. C. process. The remaining 10,000,000 gallons per day are carried away, and ultimately get emptied into the river. The effluent water passes off at the rate of a million gallons per 24 hours. A quantity placed in a glass tube was inspected by the Council, and appeared as clear as the purest water. About 45 tons of manure have already been got, which has been sold at 3*l.* 10*s.* per ton. The secretary estimates that every 100,000 gallons will produce 1½ tons of manure. The present works at Knostrop have cost about 10,000*l.*, and they can be extended, so as to deal with the sewage of the whole town in about nine months.

Trade of South Yorkshire.—The whole of the trades carried on in this district are in a most flourishing condition throughout, and in a good many cases overtime is being worked in order to keep up with the orders.

LARGE AND SMALL ROLLS.

IN "Miscellaneous Rolling Information," issued by Lewis and Rossiter, Pittsburg, [illegible] following question is asked and answered:

"Has not the diameter of rolls somewhat to do with the size of the billet necessary to fill a groove of given size? To put the question more plainly before you: Will a billet or bar that will fill to a nicety a groove of certain size in rolls of 8 in. diameter, also so exactly fill a groove of same size in rolls of 12 in. or 16 in. diameter?

"Answer. A billet that will exactly fill a groove in 8-in. rolls will over fill the same groove in rolls of 12 or 16 in. diameter, for the reason that the small roll elongates the iron more than does the larger rolls; the larger roll spreads the iron more than the smaller diameter. Templets that are used for turning grooves in guide rolls for ovals, diamonds, and other shapes show that when the templets are used for 8-in. rolls as are used for 12-in. rolls, the difference must be made by letting the rolls jump when working, or by a difference in size of billet used. A little thought on the subject will make quite plain the principle which governs the matter, which is this: The larger the diameter of rolls the greater is the bearing that they have on the iron being rolled, and instead of large rolls rolling out in length, as does the small rolls, they make the iron more dense, and, as we said, have a greater tendency to spread it.

"We give the following to more fully convey our meaning. For the sake of contrast, we have chosen nearly about the largest and smallest diameters of rolls that are employed in iron rolling. Let two pieces of iron be taken, of precisely the same size, and cut precisely the same length, and, after they are evenly heated, let one be rolled thinner on a 24 or 30 in. plate mill, and the other to same gauge on an 8 or 10 in. mill, plain rolls, allowing each to spread all that it will as it passes straight through. The piece drawn out by the small rolls will be found longer than the other, while the piece rolled on the large rolls will be found to have spread more than that rolled on the smaller rolls. Had the pieces, when rolled, been confined in a groove so that neither could have spread, even then the iron rolled on the smaller rolls would have been the longest.

"Another point touching this subject is, that iron rolled on large diameters is more solid, more closely approaching iron that has been hammered, than that which has been rolled on rolls of small diameter. This difference is not perceptible, maybe, in all cases, nevertheless it is a fact.

"In conclusion, we answer yes, the diameter has something to do with the size of billet necessary to fill a groove of certain size. A billet that will exactly fill a groove in 8 in. rolls will fit when entered in a groove of same size in 16 in. rolls."

CONDENSERS FOR STEAM LAUNCHES.—The arrangement of surface condenser for steam launches, designed by Mr. Alexander Crichton, of the Cork Steam Packet Company, and described by us on page 23 of our tenth volume, has lately undergone some further trials with very satisfactory results. Mr. Crichton has designed a new form of boiler specially applicable to steam launches fitted with condensers, and we hope shortly to be able to give full particulars of it.

SIMMONDS'S GOVERNOR.

We subjoin illustrations of an arrangement of governor for steam engines or water wheels, designed by Mr. William Edgar Simmonds, of Hartford, Connecticut, Fig. 1 being a side elevation and Fig. 2 a vertical longitudinal section. In these figures *a* shows the supporting bracket or frame, and *b* the main shaft, on which are two pulleys, *c* and *d*. The latter of these is the frustum of a cone, whose diameter at the centre of its length is the same as the diameter of the pulley, *c*. Both these pulleys are driven by belts from the drum, *e*, which is of equal diameter throughout its whole length. These belts are indicated by the letters c^1 d^3. Neither of these pulleys, *c d*, are fast on the shaft, *b*; but the shaft is made to always revolve with the pulley, *c*, by means of a pin, *f*, driven through from the circumference, its inner end projecting into a slot made in one side of the shaft, and extending from the point, b^3, to the end b^2, which, while it serves to make the shaft, *b*, revolve synchronously with the pulley, *c*, yet allows it to move back and forth lengthwise.

FIG. 1.

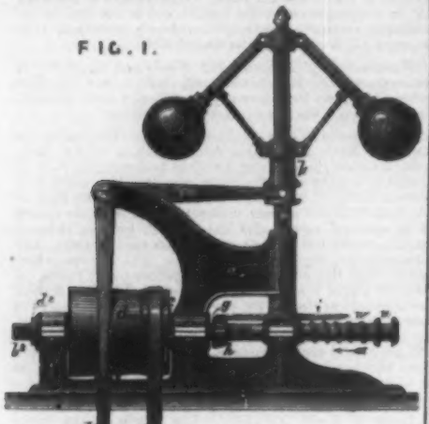
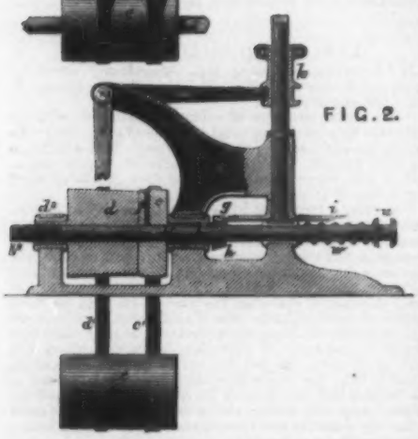


FIG. 2.



From the side of the pulley, *c*, a sleeve, *g*, fitting around the shaft, *b*, and serving as a bearing both for itself and the shaft, extends through the frame, *a*. Upon the side of this sleeve is the small bevel-wheel, *h*, gearing into the horizontal bevel-wheel, *i*, which is fast on the shaft, *j*, to the upper end of which is attached a common ball-governor, actuating the sleeve, *k*. This sleeve moves the arm, *m*, attached to the shaft, *n*, to the opposite end of which is fixed the arm, *o*, attached at its lower end to the fork, *s*, which controls the sidewise movements of the belt, d^3, so that, when the balls of the governor rise, the belt, d^3, will be shifted from the centre of the latter toward that side of the pulley where the diameter is the smallest, and when the balls fall the opposite effect will be produced.

The pulley, *d*, has a sleeve, d^2, upon its side, which serves as a bearing for itself and for the shaft, *b*. Within this sleeve a screw-thread is cut upon the shaft, *b*, which fits in a female screw in the sleeve, d^2. The effect of this arrangement is this: The ball governor is so adjusted that, at the speed which it is desirable to observe, the sleeve, *k*, will be in the centre of its vertical play, and at this point it should hold the belt, d^3, in the centre of the length of the pulley, *d*, so that it and the pulley, *c*, will revolve synchronously.

Now suppose a greater load to be thrown on the engine, or other motor, the balls will fall, and the belt, d^3, will move toward the large end of the pulley, *d*. This will cause the pulley, *d*, to revolve more slowly than the pulley, *c*, and will cause the shaft, *b*, to move lengthwise in the direction indicated by the arrow, which movement, by means of proper connexions, made from the collared groove, *u*, will allow more steam or other motive power to have access to the motor, and this movement will continue till enough of the motive power is admitted to attain the desired speed, when, of course, the belt, d^1, will move back to the centre of the pulley, *d*; but—and this is the important feature of the invention—the shaft, *b*, will not move back toward its first position unless the belt, d^3, moves beyond the centre of the pulley toward the smallest diameter of the latter. When the speed of the governor balls exceeds the desired rate this action will be reversed, and the shaft will move in the opposite direction, and the steam or other motive power will be shut off till the desired speed is again reached; but as before the shaft will not again move toward its first position till the belt, d^3, passes by the centre of the pulley, and toward the large end; so that, however much the power or the load may vary, the governor will immediately adapt itself thereto, and still maintain an uniform rate of speed. The difference between it and the common ball governor is readily explained.

In using the common ball governor no more steam can find access to the cylinder when the load is increased unless the speed slackens, and the balls are thus allowed to drop down, while to give a continuance to extra steam the balls must remain down, and the speed remain decreased, and *vice versâ*, when the load is lightened and the speed becomes too much accelerated. In Mr. Simmonds's governor, on the other hand, when the load or the power is varied, the supply of steam is modified until the requisite speed is attained, and the valve is then left at that point till the speed again varies from the desired rate. When the belt, d^3, is running on the centre of the pulley, *d*, which it will do when the balls are running at the desired speed, both the pulleys, *c* and *d*, are running at the same speed, and the shaft, *b*, is stationary so far as its lengthwise motion is concerned.

If, by any chance the end, b^2, of the shaft, *b*, should move so far out in that direction as to entirely clear the screw from the female thread, then the spiral spring, W, will press the shaft in the opposite direction, so that the screws will again engage when the opportunity is offered. The object of this arrangement is to prevent the valve or gate being operated upon after it is pulled open to its full width, as would be the case if the screw thread on the shaft, *b*, moved continuously. After the valve is open to its full width, to move it further will, of course, be of no use.

Of course, the pulley, *d*, instead of being the frustum of a cone, might be made of equal diameter throughout, and the drum which drives it might be the frustum of a cone, and the same purpose would be served.

If, for any reason, it is found desirable to have the difference between the diameters of the cone-pulley anything very considerable, then the same friction—at all times—on the belt can be attained by the use of a small idle pulley. It is not deemed necessary to show how the shaft, *b*, is connected with the valve or gate which controls the inlet of motive power to the engine or wheel, that being a very simple matter to do, the connexion being made from the collared groove, *u*. In using this governor on steam engines it can be connected directly with a stationary cut-off, or be made to control a cut-off which is the steam valve itself, or be made to control the position of the "block" in a "link," or to control any of the valves in use.

One of these governors is at work with most satisfactory results at the Phœnix Works, in Hartford, Connecticut, U.S.A., where the inventor is employed as foreman, and preparations are being made to commence the manufacture on a large scale for the American market.

THE LOSS OF THE RANGOON.

To the Editor of Engineering.

Sir,—Having since my arrival by the Simla, on the 3rd instant, been looking over the back papers, I notice there has been some speculation and surprise about the loss of the Peninsular and Oriental Steam Navigation Company's steamer on a fine quiet evening within two miles of Point de Galle harbour on the 1st November. Having been a passenger on one of the same company's steamers lying in Galle harbour at the time of the accident, and having watched the Rangoon go out, I may be able to some extent to clear up any mystification.

As to the immediate cause of the accident I give no opinion. According to hearsay, the Rangoon halted outside the harbour to pick up the Ceylon mails, and whilst doing so the current which is reported to set across the harbour mouth from east to west at the rate of four knots an hour, drifted the steamer into a position between the land and the three Cadda rocks, the latter lying about a mile from the shore to the westward of the vessel's course to Australia. That when the Rangoon hove round to resume her course, she bumped against one of them and stove in the bottom of her fore coal bunker, causing the boiler and engine-room to fill in half an hour, but had her after bulkhead been as water tight as the forward one appears to have been, the vessel ought not to have gone down. The Cadda rocks have from 2½ to 2¾ fathoms water on them. After striking the rock, the Rangoon appeared to keep on her course some half mile further out to sea, and then becoming unmanageable, she drifted westward by the current until brought up by anchoring near a couple of sailing vessels lying at anchor outside, to which the passengers were transferred at about 8 p.m., the Rangoon having taken her departure at 6 p.m. just as it was growing dusk. Towards 9 o'clock the company's steamer Baroda (having previously sent her boats together with those of the Indus) was ordered out to the assistance of the Rangoon; it was, however, midnight before the Baroda got under way, and whilst she was steaming out the Rangoon tossed her bow in the air and went down on a level bank in 15 fathoms, the only water so shallow in that neighbourhood at about two miles from the shore. She lay nearly upright with her top sail yards awash.

The buoys which mark the positions of rocks are lighted up to enable vessels to take their departure at night, but they are not allowed to attempt to enter at night which probably accounts for the Rangoon's head not having been at once turned for the port, or for the steamer Arcot, 1000 tons, which had her steam up, not having been sent to tow the Rangoon in, as the Arcot might have forfeited her insurance had she come to grief." It is said the water rushed into the stoke hole through the bunker door, which had a vertical sliding shutter to be worked down by a ratchet to provide against the very contingency which occurred; but the ratchet was either too low down or forgotten or the door would not shut, or, if when shut, was of no use. In any case, it was of no importance whilst the after bulkhead was not tight.

The following outline plan from memory of the harbour of Point de Galle will make the explanation better understood:

The raising of the Rangoon is merely a financial question. During the next five or six months, the winds will be light and from the N.E. Squalls may be expected in March and April.

The harbour is in a pretty bay about three miles wide and deep, having a general depth of seven fathoms, with a sandy bottom. The bay is open only in a south-easterly direction, and is bounded by high land on the east and west; it is therefore well protected from the south-west and north-west monsoons; it is frequented by most passing steamers and ships for coals and orders, &c. On the 31st October there were seven steamers in the harbour, five of them P. and O. Co.'s steamers met to exchange mails, passengers, and cargo. One may therefore safely conclude that the improvement of the harbour is well worth consideration, although it has been pooh-poohed by the engineers lately employed by the Ceylon Government.

There are some twenty rocks in the bay strewn about without any regularity, twelve of them, including the three Caddas, are in the way of shipping. Their removal would enable ships to enter and leave the port without a pilot, and at any hour, or in any weather, day or night, and the harbour anchoring would then be about 2½ miles long by 1½ wide, sufficient to allow a goodly number of vessels to swing at their anchors instead of having to be moored head and stern as at present.

Immediately to the south of the island there is a bank of about half an acre of rocks on which there is only half a fathom of water; the bank is not at all in the way, but it should have a large beacon built on it, and furnished with an ordinary red lamp light for assisting vessels to steer in at night. The same treatment, the light excepted, would do for a point of rock near the town side, on which there is only 1½ fathoms of water; the remaining rocks have from 2½ to 3 fathoms water on them. I have reason to believe, from inquiries made, from the appearance of the island, and the natural breakwater which contracts the entrance of the bay on the western side, that the rocks are of small dimensions, probably the blunted points of conical stone heaps, similar to the island, in which case the whole of them could be removed to 4 fathoms deep by a single 2 in. bore blast each—the Caddas might take two or three blasts each, but not more, so that at the rate of 100*l.* per blast, or say 5000*l.* for all works, Galle harbour may be made as comfortable a port as any captain would wish to meet with.

From a financial point of view there need be no difficulties. The present pilotage ground is only about 1½ miles long, for which every vessel has to pay 5*l.* in and out, besides port charges for stern moorings, say 6*l.* in all. After the works indicated were finished, a charge of 3*l.* per vessel for harbour improvement dues would pay off the outlay in three years on the present usage of the port; a charge of 30*s.* a vessel for another period of three years would return an ample interest on that outlay.

I am, Sir, yours faithfully,

London, December 9, 1871. J. Tipping, C.E.

A Winter Garden at Rome.—Among the many improvements about to be made in Rome (one which will be particularly grateful to the visitors to the queen of cities, the Old City of the Seven Hills, just awaking to a sense of a new life) will be the laying out and building of a magnificent winter garden, which will be situated in the centre of the city, and attached to which there will be a café, theatre, and an open-air theatre for concerts in the gardens; the plans for which are now being sent from England by Mr. Walter Emden, architect, 8, Adam-street, Strand. Connected with the same plans will be an opera house, which is intended to be the National Theatre of United Italy, with her 27,000,000 of busy people, as yet hardly conscious of their growing strength and prosperity. Many of the highest and most influential names in Italy will be patrons of the scheme.

ROTARY SHEARING MACHINE.

DESIGNED BY MR. ROBERT BRIGGS, ENGINEER, PHILADELPHIA, U.S.A.

FIG 1.

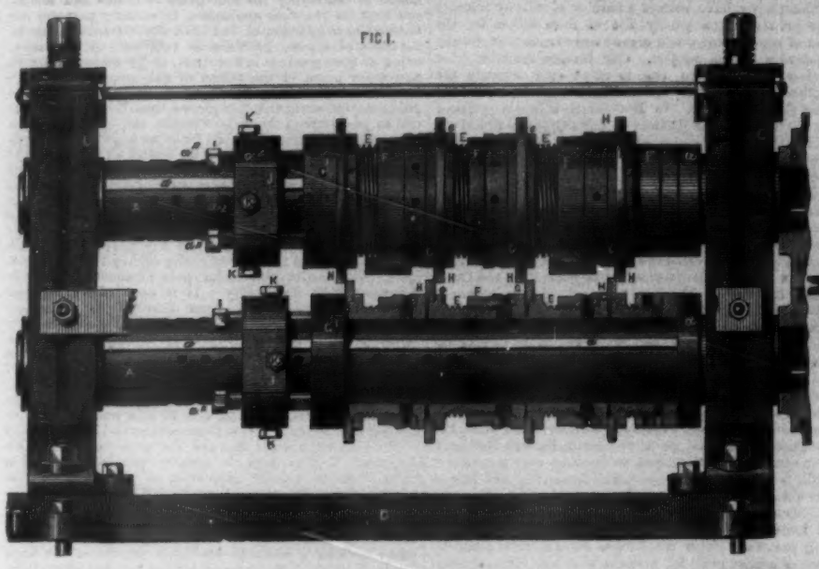


FIG.2.

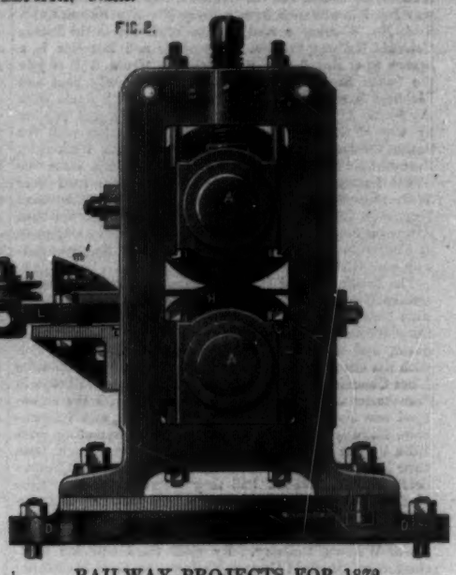


FIG.3

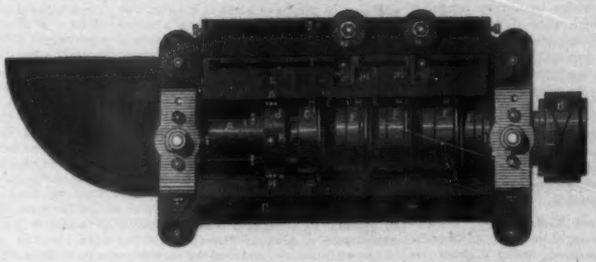
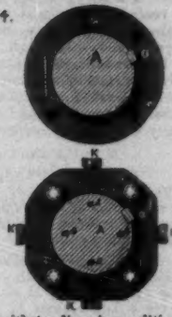


FIG.4.



WE annex illustrations showing arrangements for adjusting the cutting discs of rotary shearing machines which have been designed by Mr. Robert Briggs, of Philadelphia, and which have been lately patented in this country. Mr. Briggs's plans may be best described by referring at once to the engravings, in which Fig. 1 shows an elevation of a shearing machine with his plans applied; Fig. 2 is an end view; Fig. 3 a plan drawn to a smaller scale; and Fig. 4 a transverse section through the cutter shafts, showing an end view of the fixed collars and follower collars.

In these figures A, A, are the cutter shafts geared together by pinions, B, B, and mounted in the headstocks, C, C, fixed to the bedplate, D. Upon the shafts, A, A, are slid the sleeves, E, E, fitting with grooves over the feathers, *a*, *a*, of the shafts. The sleeves, E, have screw threads formed upon their outer surface as shown, and upon them are screwed other sleeves, F, F, with internal screw threads. At one end of each sleeve, F, is placed a follower collar, G, which collars hold the cutter rings, H, against the flanges, *e*, on the end of the sleeves, E, the end cutter ring being held by the collar, G^1.

Thus it will be seen that by screwing the sleeves, F, more or less upon the sleeves, E, the spaces between the cutter rings may be adjusted to the exact extent required. The right distances between the cutters having thus been obtained the whole system is clamped together by the screws, I, I screwing through the adjustable collars, J, J, and bearing against the collars, G^1, while the end sleeves, E^1 and F^1, bear against the fixed collars, a^1, a^1, on the shafts, A, A. The adjustable collars, J, are secured on the shafts, A, by means of set screws, K, which enter into recesses, a^2, a^2, formed on the shafts.

Upon the guard plate, L, are placed the guards, M, M, adjusted in the slot, *l*, of the guard plate to such positions that the end of the sheared strip of metal which has been depressed by the shearing action of the cutters, H, shall pass along the side surfaces of the guards under the lips, *m*, *m*, and the ends of the two contiguous sheets or strips which have been elevated by the shearing action of the cutters shall pass along the surfaces, m^1, m^1, of the guards and be carried above the guide rollers, N, N.

The middle strip thus described as passing along the surfaces of the guards, M, M, enters into the grooves of the guide rollers, N, N, which rollers can be so adjusted in the slot, *l*, of the guard plate, L, that a straight line direction shall be given to the sheet or strip after it emerges from the cutters, and it is stated by the patentee that it has been found practicable to shear up ordinary sheet iron with the ordinary irregular edges as they come from the rolls of a sheet mill (which edges do not afford any facility for guidance) into straight parallel strips notwithstanding inequalities of thickness or buckles in the plates, and notwithstanding inequalities of diameters or unequal sharpness or irregular setting of the circular cutters at least within the limits of their irregularities in practice. In place of the guide rollers, N, grooves can be formed in guide blocks of metal, of hardened steel for instance, but the construction described is preferred.

A similar disposition of guard plates and rollers or fixed guards may be affixed to the back side of shears having reciprocating knives or cutters as in ordinary plate shears, only with several cutters to shear two or more parallel edges at once.

RAILWAYS.—A few further figures from the railway returns will not be without interest. At the close of the year 1860 there were 10,433 miles of line open in the United Kingdom; at the close of 1870 the number of miles constructed was 15,537, showing an increase of nearly 50 per cent. In England (including Wales) the increase in the ten years was from 7383 miles to 11,043; in Scotland, from 1486 to 2519; in Ireland, from 1364 to 1975. The number of passengers carried by the railways of the United Kingdom increased from 163,435,678 in 1860, to 330,004,398 in 1870, or more than 100 per cent., and this is exclusive of season and periodical ticket-holders, the number of whom increased at a much greater rate — viz., from 47,894 to 156,403. In England the number of ordinary passengers increased from 136,958,904 to 288,633,921, and the season and periodical ticket-holders from 30,500 to 118,110; in Scotland ordinary passengers from 16,493,221 to 27,046,864, and season, &c., ticket-holders from 9820 to 23,462; in Ireland, ordinary passengers from 9,983,553 to 14,324,613, and season, &c., ticket-holders from 7565 to 14,831. The number of miles travelled by trains (whether passenger or goods trains) increased from 102,245,692 in 1860 to 169,067,372 in 1870, an increase of 65 per cent.; in England from 85,701,925 to 139,010,284; in Scotland from 11,097,121 to 21,815,174; in Ireland from 5,444,646 to 8,241,914. At the close of the year 1870 the capital received by the railway companies of the United Kingdom amounted to 34,106*l.* per mile constructed; in England, 39,680*l.*; in Scotland, 24,816*l.*; in Ireland, 13,786*l.* The net receipts of the railways of the United Kingdom in 1870 were equal, upon an average, to 1504*l.* per mile; in England, 1801*l.*; in Scotland, 963*l.*; in Ireland, 528*l.* The (gross) receipts from ordinary passengers on the railways of the United Kingdom in 1870 (not including season ticket holders) show an average of not quite a shilling per passenger; in 1860 the average exceeded 10d.—*Times.*

RAILWAY PROJECTS FOR 1872.

(*Concluded from page 379.*)

THE Midland Railway Company have made several deposits in connexion with their lines. In the first place they propose a line of 10¼ miles from Hassop to Dore to connect the Rowsley and Buxton Railway with their Chesterfield and Sheffield line. They next propose a line of 5½ miles, commencing at the Ilkeston Station of their Erewash Valley line, and terminating by a junction with their Nottingham and Mansfield line at Bulwell. A branch line, 1¾ miles in length, is proposed from the Bulwell line to Greasley, and is to be called the Watnall New Colliery branch. Next comes a line of 4½ miles, to be called the Gloucester and Berkeley New Docks branch, which will start from the Bristol and Gloucester line at the Berkeley-road Station, and will terminate near the Gloucester and Berkeley Canal. From this last branch they propose a fork of half a mile back to the Bristol and Gloucester line. In Yorkshire they propose a junction between their Leeds and Bradford line at a point where that line crosses the Bradford Canal, and terminating by a junction with the company's Otley and Ilkley extension at Guiseley. By another Bill the Midland Company propose a line of 14¾ miles, to be called the Shirecoaks and Doncaster Railway. It will form a junction between the company's Mansfield and Worksop line, now in course of construction, and the South Yorkshire line of the Manchester, Sheffield, and Lincolnshire Railway Company. By a fourth Bill the Midland Company seek powers to construct five lines, the first of which is 21¼ miles in length, and commences by a junction with the company's Nottingham and Lincoln line at Nottingham, terminating by a junction with their Syston and Peterborough line at Saxby. The Manton and Rushton line is 14 miles in length; it commences by a juncton with the Syston line at Manton, and runs into the Midland main line at the Rushton Station. From the first proposed line—the Nottingham and Saxby—a branch, of 4¾ miles, to be called the Croxton branch, is proposed. Another branch line, of 1¼ miles, is proposed at Melton Mowbray, and, finally, a short curve of 3 furlongs is to connect the Manton and Rushton line with the Syston and Peterborough Railway at Manton. The above lines and branches give a total length of about 82 miles.

Under the title of the Midland and South Staffordshire Railway, we have six lines proposed. The first leaves the Midland Railway at their Water Orton Station, and passing by way of Sutton Coldfield, terminates at Aldridge, Stafford. The second line commences at the termination of the first, and joins the South Staffordshire Railway at Rushall. The third proposed line will unite the second with the Wolverhampton and Walsall Railway, now in course of construction. The fourth line will be a branch from the first, leaving it at Aldridge, and terminating at Norton. Line No. 5. is a continuation of the last to the Cannock and Rugeley Colliery Company's workings, whilst No. 6 is a branch from No. 4 to the Cannock Chase Collieries. The Midland and South Stafford Railways Bill includes nine lines, the first of which starts from the Birmingham and Derby section of the Midland Railway at Curdworth, terminating near the Birmingham and Kingsbury turnpike road. The second line is a branch from the Birmingham and Derby line at Castle Bromwich to the termination of line No. 1. The third line starts from the termination of the second, and terminates at Sutton Coldfield. The fourth line is a continuation of the third to Walsall, where it is to

join the deviation line of the Wolverhampton and Walsall Railway. The fifth line is to connect the fourth with the South Staffordshire Railway, whilst the sixth is a junction between the fourth and the Cannock Chase Railway. Railway No. 7 is a branch from railway No. 3 to Sutton Coldfield, No. 8 being a continuation of No. 7 to the Sutton Coldfield Railway Station. The ninth and last line is a branch from Nos. 7 and 8 to Lichfield, where it is to join the South Staffordshire Railway. The Birmingham and Lichfield Junction Railway is a scheme which starts from the South Staffordshire Railway at Lichfield, and passing by way of Shenstone, terminates by a junction with the Sutton Coldfield Railway, where it crosses the Park-road, Sutton Coldfield. A branch line is proposed from the Grand Junction Railway, where it crosses the road from Wolverhampton to Stafford to Brewood. The Cleveland Extension Mineral Railway is a line from the Saltburn extension branch of the North-Eastern Railway Company at Skelton to the North Yorkshire branch of the same railway near Glaisdale, in the North Riding.

The South Midland Railway scheme has for its object the construction of railways from Lydney to Wootton Bassett, from Nailsworth to Malmesbury, from Dudbridge to Stroud, from Wootton Bassett to Hungerford, and thence to Andover, and from Knitbury to Basingstoke, i. connexion with the Great Western and other railways. The Cheshire Lines Committee apply for powers to construct railways in Manchester and Warrington in connexion with the authorised new lines of the Manchester, Sheffield, and Lincolnshire Railway. This latter company are promoting three Bills, by the first of which they propose a branch from their line at Ki- ton Park, in the West Riding, to Chesterfield. By their second Bill they propose a railway from Market Harborough to Worksop, with a branch to Nottingham. The line will connect the company's railway with that of the Rugby and Stamford branch of the London and North-Western Railway. By their third Bill the Manchester and Sheffield Company ask powers for a branch line with connexions, starting from their own line at Worksop to Doncaster, where it is to join the railway of the South Yorkshire Railway and River Dun Company. The Lancashire and Yorkshire Company propose to extend their Shawforth branch to their Bacup branch, to construct a branch from their line at Newton, Manchester, to Hollinwood; also a branch from their line at Long Millgate, Manchester, to their East Lancashire line at Radcliffe. From the latter point the line is to be connected with the Liverpool and Bury line, in Radcliffe. This company in the same Bill propose a branch from their Blackburn, Darwen, and Bolton line at Eccleshill to Over Darwen. The proposed Market Harborough and Worksop and Nottingham Railway is a line from the Rugby and Stamford branch of the London and North-Western Company to the Manchester, Sheffield, and Lincolnshire Railway at Worksop. The Nottingham line is a branch from the first, which it leaves at Colston Bassett, terminating in the town of Nottingham. The proposed Newark, Melton Mowbray, and Leicester Railways consist of eight lines and branches. No. 1 is from Newark to Bottesford; No. 2 from the latter place to Melton Mowbray, and No. 3 from the latter place to Leicester. Nos. 4 and 5 are branches to the Great Northern Railway at Bottesford, No. 6 being a branch from No. 2 to Waltham; No. 7 a branch to the Midland Railway at Melton Mowbray, and No. 8 a branch to the same line at Leicester.

The Northampton and Banbury Junction Railway Company propose a junction between an authorised branch of their line and the Bedford and Northampton Railway at Northampton. The proposed Northampton and Daventry Railway starts from Dodford, Northampton, and terminates by a junction with the Bedford and Northampton Railway at Northampton. The North-Eastern Company propose to construct railways between Sunderland and Hartlepool and the Stockton and Darlington lines, and at Middlesbrough and York. They also propose to divert the River Don at Jarrow Slake, and construct quays and wharves on the banks of the river when diverted. The London and North-Western and the Caledonian Companies and the Citadel Station Committee are applying for an Act to enable them to construct a number of new lines and connexions as well as a new street near the Citadel station, Carlisle. The railway scheme consists of no less than twelve short lengths of line. The proposed Liverpool and Birkenhead Subway and Railway starts from James-street, Liverpool, passes under the Gorse warehouses, and the George's Dock Basin, and thence under the River Mersey to Argyle-street, Birkenhead. Another proposed line in Liverpool is to run from the Brunswick station of the Garston and Liverpool Railway to Huskisson Dock. There are four sets of plans deposited for railways to cross over the Severn by bridges, and one for a line to pass under it by a tunnel. The first line commences by a junction with the South Wales Railway at Caldicot, and crosses over the Severn to the Bristol and South Wales Union Railway at Almondsbury. The second scheme connects the same two railways, leaving the former at the Chepstow Bridge, and joining the latter at Almondsbury. The third bridge scheme comprises several lines of railway for connecting the lines eastward and westward of the Severn, and a new road and bridge in connexion with the railway bridge over the river. The fourth scheme consists of a line from the Lydney station of the South Wales Railway to the Gloucester and Berkeley Canal Company's new Docks at Holly Hazle with branches. There is to be a toll bridge over the Severn connecting Lydney with Berkeley. The tunnel scheme leaves the Bristol and South Wales Union Railway, at Almondsbury, and passing under the Severn joins the South Wales Railway at Rogiet.

Although we have noticed a number of railway schemes there yet remains a goodly list of lines before us, the names of which alone would occupy more space than we can now devote to the subject. Our further remarks must therefore be brief; we can in effect only indicate the direction in which surveyors and levellers have been busy during the past month. In Devonshire a line is proposed from the South Devon Railway at Laira Green to Plymouth and Devonport. We also observe that the Devon and Somerset Company are applying for powers to raise additional capital, and for an extension of time. There is also an application to revive the powers of the Henley-in-Arden Railway Acts of 1861 and 1864; the line is but a short one of some three miles or so, and is partly constructed. A similar application is also made in respect of the Ipswich and Felixstowe Railway Act, 1865. Then there is a branch line proposed to be made from the Great Western Railway at Windsor to Ascot, also a system of narrow gauge lines in connexion with the Whitehaven iron mines. There are of course a number of deposits in connexion with Irish, Scotch, and Welsh railways, as also for lines in the Isle of Wight, a railway from Llanberris to the top of Snowdon, as well as for tramways everywhere. Amongst the miscellaneous deposits we find one for a system of International communication by means of steam vessels and a new pier at Dover in connexion with the London, Chatham, and Dover and South-Eastern Railways, of the success of which scheme we have no very great hope. A Bill for a similar purpose on the Newhaven and Dieppe route carries with it no greater amount of promise than the previous one. Another interesting scheme is the Brighton and London sea-water supply, by which it is proposed to bring sea water from the former to the latter place, by means of sundry pumping stations and reservoirs situated *en route*. There are of course a number of Bills for piers, harbours, gas works, water works, as well as for various improvements. These all go to make up a very long list of Private Bills, one, however, which we shall find considerably shortened by the time the Committee commence their work. We shall as usual watch the progress of events in railway committees, which bodies, we believe, will have some heavy work to get through during the Session of 1872.

CHARCOAL AIR FILTERS.

The following interesting letter addressed by Dr. Letheby to the editor of the *Times*, and relating to the power possessed by wood charcoal of oxidising sewer miasma, is so deserving of attention that we reprint it.

To the Editor of the Times.

Sir,—The power which wood charcoal possesses of absorbing and oxidising, or slowly burning, sewer miasma deserves a larger share of public attention than the very modest letter of its discoverer, Dr. Stenhouse, in the *Times* of yesterday is likely to secure for it. It has long been known to chemists that charcoal has the property of absorbing offensive effluvia, for at the close of the last century Löwitz, a German chemist, directed attention to the fact that powdered charcoal would deodorise and disinfect most putrid substances, and in the year 1805 Giraud recommended it for the deodorisation of night-soil. In 1814 the subject was investigated scientifically by Theodore de Saussure, who ascertained the exact volume of different gases and vapours which wood charcoal would absorb. Since then the question has been further explored by Figuier, Bussy, Thenard, Allen, and Pepys, Count Morosso, and others; but it was not until the year 1858 that the facts began to acquire practical importance through the labours of Dr. Stenhouse, whose researches in this and other directions have recently gained for him the distinguished honour of being one of the Royal medallists of the Royal Society. Dr. Stenhouse was first struck with the fact, communicated to him by Mr. John Turnbull, of Glasgow, that when the bodies of dead animals are covered over with a few inches of powdered charcoal, and exposed to the air, though the bodies rapidly decay, yet not the slightest disagreeable odour is evolved. This result he verified in 1853 by burying the bodies of a full grown cat and two rats in about 2 in. of charcoal powder and keeping them in his laboratory, where eight or nine persons were daily at work. The bodies of the animals rapidly decayed as usual, but without discoverable effluvium of any sort of offensive consequences whatever, for the charcoal absorbed the putrid gases and caused them to enter into chemical combination with the oxygen of the air, forming innocuous and odourless compounds. The change, in fact, was of the nature of slow combustion, and was as effective as if putrid vapours had passed through the ignited coals of a furnace. He then charged some atmospheric air with ammonia, with sulphuretted hydrogen, and with sulphide of ammonia, and in each case passed it through a vessel containing wood charcoal, when he found that the air was completely deprived of its offensive properties, and could be breathed with impunity. These results suggested the use of charcoal respirators and air filters, and soon after he proposed the use of charcoal as a means of disinfecting the foul gases which escape from the street gullies and the drains of private houses. A specimen of his charcoal air-filter was publicly exhibited at the meeting of the Society of Arts in February, 1854; and the subject was fully discussed by Dr. Stenhouse in a lecture on "The Economical Applications of Charcoal to Sanitary Purposes," which he delivered at the Royal Institution on the 2nd of March, 1855. Three years after that, having repeated his experiments and verified his conclusions, I brought the subject under the notice of the Commissioners of Sewers for the City of London, in my report on "Sewage and sewer gases, and on the Ventilation of Sewers," saying that we had in wood charcoal a powerful means of destroying the foul gases of drains and sewers, and that its practical application to sanitary purposes was fortunately a question of but little embarrassment, for in the case of sewers, let them be ventilated as they may, either by open gratings in the street, or by connexions with rain-water pipes, or the pillars of gas-lamps, or by tubes from the drains of every house, or by special shafts in the public streets, we have but to place a small box of wood charcoal in the course of the outlet draught, and the purification of the air will be complete. As far as we know, the strength and the endurance of this power are almost unlimited, so that when once the charcoal air-filter has been set up it will last continuously for years. These suggestions were at once adopted by the Commissioners of Sewers, and the engineer, Mr. Haywood, was instructed to report on the practical means of putting them into operation. A large district of the City was therefore selected for the purpose, and Mr. Haywood designed the plan of giving efficacy to the experiment. The district comprised a space of about 50 acres in the worst part of the City. It is bounded by Bishopsgate-street on the west, from Cornhill to Widegate-street; by Whitechapel on the east, from Middlesex-street to Somerset-street; and thence along the Minories and Leadenhall-street to Cornhill on the south. In this space there are about 14,000 inhabitants living in about 1700 houses. The total length of sewers is about 25,587 ft., and along these there are 104 air-shafts, 265 gullies, 15 flushing-shafts, 4 tanks, and 26 side entrances. This district was selected for various reasons:—1. Because the sewers have but a slight fall and the currents in them are sluggish; 2. The area is densely populated and has more than an average proportion of poor in it; 3, the thoroughfares are mostly narrow, and are, therefore, disagreeably affected by the sewer gases which issue from the ventilators; 4, the district affords comparatively good means of isolation from the sewers. Each of the 104 air-shafts was provided with a charcoal ventilator mostly of the form designed by Mr. Haywood—namely, an iron box about 18 in. deep and 14 in. square, containing a movable frame of six trays or sieves, upon each of which a layer of wood charcoal, in pieces as large as filberts, was placed to the depth of 2 in. The experiment was commenced in the month of July, 1860, and it has been successfully continued to the present time, for to use the words of our conjoint report on the subject, "the deodorising power of the charcoal has been satisfactorily proved to be complete. Not only have there been no complaints from the public of stenches from the ventilating openings, but we have ascertained by actual observation that the odour of the sewer gases is not perceptible when they have traversed the charcoal. This, indeed, might have been predicted from the extensive laboratory experiments and the other practical inquiries to which we have alluded." Charcoal from the ventilators has been submitted to chemical examination by me after having been in action for from nine to twenty months, and when heated with water it yields abundance of alkaline nitrate, showing that some of the organic miasmata have undergone complete oxidation. But besides these compounds others are present in the charcoal—namely, peculiar alkaline salts, which indicate the fixation not only of ammonia, but also of other volatile nitrogeneous bodies which are peculiar to animal decomposition. Our general conclusions from these experiments were thus expressed:—

"That dry charcoal in the presence of atmospheric air is a powerful means of destroying the mephitic gases and vapours of sewers and house-drains; that the charcoal air-filters may be used with efficacy in the course of the air channels from the drains and closets of houses, as well as in the ventilation of the public sewers; that, in applying the charcoal, those contrivances should be used which offer the least resistance to the free passage of air through the charcoal. That the situation of the filter is best when the charcoal is protected from wet and from dirt, and is easily accessible, and that, from the ascertained efficacy of charcoal in destroying the dangerous emanations from sewers, the system may be generally applied with great advantage."

The simple question, therefore, for the young and aspiring architect, to whom you have alluded in your leader of to-day, is the means of applying in the most certain and easy manner the disinfecting power of charcoal to the sewers, the drains, the soil-pipes of our streets and houses.

I remain, yours truly,

Hy. Letheby, M.B., M.A., &c.,
Medical Officer of Health for the City of London.
17, Sussex-place, Regent's Park, December 9, 1871.

The Mouth of the Neva.—M. Nicholas Putiloff, a rather noted Russian iron manufacturer, has propounded a scheme for establishing a new port at the mouth of the Neva. The plan, according to the details given by M. Putiloff, is to open a passage for goods direct from the Upper Neva to the Gulf of Finland without transshipment, by cutting a canal 12 miles in length from Alexandrovski (some distance above the capital) to M. Putiloff's factory on the shore of the gulf, beside Volni Island. It is further proposed to construct a harbour at this battery-point, traversed by a custom-house quay two miles in length and containing three basins—one for outward-bound shipping, another for vessels arriving from abroad, and a third for lighters—as well as a floating dock for repairs. It is also in contemplation to cut a canal through the gulf in the direction of Cronstadt from the extremity of the harbour (where the water is 12 ft. deep) to the 18 ft. level, a distance of nearly four English miles, and to lay down a railway parallel or nearly so with the overland canal from Alexandrovski to the Putiloff factory and thence in three branches along the custom-house quay and the outer embankments to the extremity of the near harbour. The cost of all these works is estimated at 2,700,000*l*.

LITERATURE.

A Digest of Facts relating to the Treatment and Utilisation of Sewage. By W. H. CORFIELD, M.A., M.B. Macmillan and Co., London.

[CONCLUDING NOTICE.]

In the third and concluding notice of Mr. Corfield's valuable book, we propose to review with some care the information which he has collected and laid before the reader upon the utilisation of sewage discharge from towns, and the conclusions that may be fairly drawn from the now not inconsiderable experience we possess upon this subject. And, first, with regard to the absolute fertilising value of excreta. In a paper, read before the Society of Arts on March 7, 1855, by Mr. Lawe, F.R.S., the results of a great number of analyses of fœces and urine were given. The following Table may be considered as approximately correct.

	Fresh excrement.	Dry Material	Mineral matter.	Carbon.	Nitrogen.	Phosphate.
Fœces ...	4.17	1.041	0.116	0.443	0.053	0.068
Urine ...	46.01	1.735	0.527	0.539	0.478	0.189
Total ...	50.18	2.776	0.643	0.982	0.531	0.257

This Table shows that in each component part, the urine is more valuable than the fœces, the nitrogen being 9 times greater, and the phosphates nearly 3 times in excess by weight in a given time. But the proportions sometimes vary considerably, the fœcal phosphates being often greater than those given above.

It is not, however, with such proportions or material that the work of utilisation has to do. The composition of diluted sewage matter varies so much, that it is difficult to approximate its value, and to arrive with any degree of exactness at the truth, mean value after mean value must be taken, at different seasons, different hours of the day, and different conditions of the sewers, before a fair result can be attained.

According to careful investigations by the Rivers' Pollution Commissioners in 1868, in water-closet towns, 100,000 parts of sewage contained 72.2 parts of solid matter in solution, in which there are 4.696 parts of organic carbon, 2.205 of organic nitrogen, 6.703 of ammonia, an almost inappreciable quantity of nitrogen as nitrites and nitrates, the total of combined nitrogen being 7.728 parts, and the chlorine 10.6 parts. Besides the matter in solution, the 100,000 parts contain 44.69 parts of matter in suspension, of which 24.18 are mineral, and 20.51 organic.

But this average is a very untrustworthy one, as regards localities, where far different proportions may exist. Thus, in the London sewage, the combined nitrogen varied from 3 to more than 11 parts per 100,000, while in all the samples examined, the variation ranged from 2.371 parts to 24.325 parts. It must be borne in mind that sewage is not composed only of human discharge, but in addition, of a vast quantity of animal refuse, of vegetable garbage, of blood, of street filth, outpourings from factories, warehouses, and private houses, so that it may be rather regarded as water polluted by a large variety of abominations than an excrement diluted with water.

We have already stated that the estimated annual value per head of excrementitious matter is 8s. 6d., assuming the amount of ammonia to be 12¼ lb.; but this has been considered too high a sum, and 6s. 8d. has been assigned as a minimum value.

The valuable ingredients of sewage are the different forms of combined nitrogen, and phosphoric acid and salts of potash. The money value of these constituents dissolved in 100 tons of average sewage is 15s., while the suspended matters are worth only 2s. So that average sewage is worth about twopence a ton. Other investigations show that 70,000 tons of average sewage contain 100 tons of solid matter, of which 3 tons are ammonia, worth about 44*l.*, and the whole of the mass would be worth some 60*l.*, or a little more than 6*d.* a ton.

The aggregate value of the sewage diluted as it is becomes enormous in large towns; thus Baron Liebig and Mr. Ellis estimate that 266,000,000 tons is the total annual amount of London sewage, and this valued at one penny per ton, according to the view contained in the third report of Sewage of Towns Commissioners for 1865, would give the sum of 1,108,333*l.* as the yearly value of the London sewage. Messrs. Hofman and Witt give a higher estimated value, and Baron Liebig asserts that the actual yearly value is 4,081,430*l.*

Commercial objects apart, towns are naturally founded upon the banks of rivers, in order that an easy water supply may be obtained, and that a simple means of getting rid of sewage may be at hand. In small communities, and even in large towns situated on wide and deep streams, the evil effect of following this primitive method remained long comparatively unfelt, and still longer little understood; and to-day now that the full danger of such a system is known, sewage continues to be poured into our streams, which are made to yield a drinking supply, or, as in the case of London, works at a vast expense are constructed to remove the evil, with the result of only mitigating it. For example, the Tame before reaching Birmingham receives—to say nothing of manufacturing refuse—the discharge of more than 270,000 persons who combine to swell the nauseous flood of the stream until in dry seasons it contains more sewage than water. At Stratford the river is rendered filthy by the sewage which flows into it; that branch of the Avon which receives the sewage of Salisbury has often to be cleaned out to prevent it from being choked up. The Isis at Oxford is often a settling mass of impurities from the fœcal matter mixed with it.

In 1868 the Rivers' Pollution Commissioners stated that the improved sewage works at Bury and other towns had been executed at the expense of the Irwell and the Roche, which became saturated with sewage, and the waters rendered useless for mechanical purposes.

With regard to the effect of sewage upon water used for drinking purposes we see around us at all times, and of course more especially in summer, and in seasons of epidemic, its fatal consequences are most strongly marked, and the investigation of the Rivers' Pollution Commissioners upon this point are full of interest. Dr. Frankland gives it as his opinion that there is no process practicable on a large scale by which water once contaminated by sewage can be purified for drinking purposes. He also states that about four-fifths of the nitrogeneous matter contained in fresh sewage is decomposed before the sewage, after a run of two or three miles, emerges into the river, and the remainder is decomposed with extreme slowness after. This statement is substantiated by the analyses given in the first report of the Rivers' Pollution Commissioners.

Despite the decided opinions expressed against the use for drinking of any water once contaminated by sewage, there exist many able advocates of an opposite view; thus Dr. Miller considers that oxidation goes on in rivers to a very perfect extent, and that river water, after being contaminated, is still safe for drinking in the majority of cases. So adds Dr. Letheby, who considers that the present water supply of London is thoroughly wholesome, and that ordinary sewage mixed with its own bulk of water, after floating a dozen miles or so, is entirely decomposed, and there is "not a particle of the sewage to be discovered by any chemical process." Were this indeed a fact, we might obtain a pure and abundant supply of drinking water for London from the Barking pumping station. Dr. Odling and Mr. Hawksley lean towards Dr. Miller's opinion, but all these theories are answered by the incontrovertible statistics of the mortality bill, and the gradual decrease of the death rate of London as the source of supply has moved up the river.

We will now proceed to notice as completely as our space will admit the various attempts that have been made to utilise the sewage matters of towns, both with a view to profit and to the improvement of a sanitary status. Naturally the first attempt at purification would be to allow the sewage matter to stand and settle, then to run off the water, and empty the subsided mud. In Ely the solid parts are separated from the liquid by upward filtration, the liquids entering the river with all their soluble impurities. The solid parts, mixed with coal-dust and road rubbish, are sold for manure. At Rugby, Ashby-de-la-Zouch, Banbury, and Chelmsford, filtration and settling processes are in force, with more or less of success, but in none of them is the decided degree of purification effected. As an additional means towards arriving at this end various so-called precipitation processes have been devised, of which perhaps the most important is called the lime process, used in Tottenham, Blackburn, and Leicester with considerable success, as evidenced by the apparent condition of the water and the return of fish to their old haunts. The process consists in mixing with the sewage a certain proportion of cream of lime, after which a copious deposit of highly putrescible mud takes place, while the supernatant liquid flows off in a comparatively clear, though somewhat milky condition. Fifteen or sixteen grains per gallon are sufficient to precipitate ordinary sewage, but no element of agricultural value is preserved by it, except five-sixths of the phosphoric acid. This process, in common with others of the same class, produces an effect apparent rather than real, cleansing the water to the eye, but leaving it unfit to mingle with flowing streams, and saving none of the chief fertilising agents. At Northampton there is a modification of this process consisting of filtration, after precipitation with lime and chloride of iron, through an 8 in. bed of calcined iron ore, but the effect produced is insignificant. Perchloride of iron has shown itself to be a valuable precipitant, but Professor Wey has shown "that this process cannot boast, any more than those formerly described, of any power of separating ammonia or other manuring material. It, however, proves a good deodoriser. Chloride of iron, and salts of zinc, and manganese have been tried and abandoned, amongst other reasons, on the ground of expense. Carbolate and sulphite of lime and magnesia have been used, but chiefly as disinfectants, and Blyth's process, which involves the use of superphosphate of magnesia, promised well, but failed. Holden's process is pretty well known. It consists in adding to the sewage a mixture of sulphate of iron, lime, and coal-dust, and allowing a gradual subsidence, but while it has the property of throwing down all suspended matters, it absolutely increases the putrescible organic matter in solution, and the manure is practically worthless. Bird's method consists in the use of crude sulphate of alumina; the results of this were much the same as others of its class. This series naturally leads us to the so-called A. B. C. process, about which so much has been said, and for which the inventors apparently sought to borrow a species of divine right, alleging they received this idea from the Bible. Whether this nonsense had any effect on the public mind, or whether the inventors were more energetic than their predecessors, the A. B. C. process has been more discussed than any other of its class, but apparently without one whit more claim to efficiency. We have already expressed our opinion of this process, and shall probably have occasion to refer to it when the new works are opened at the southern outfall.

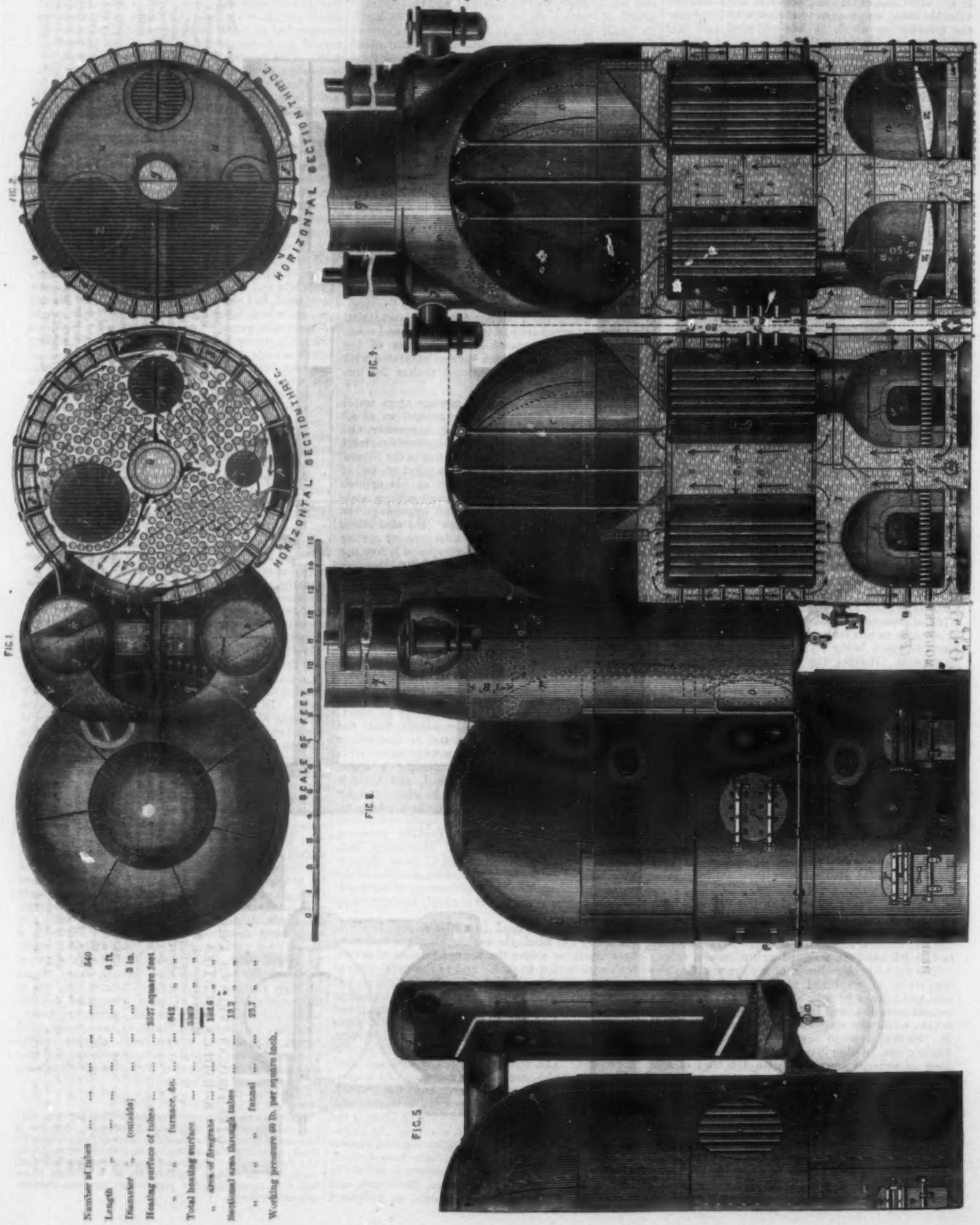
We have not the space here to follow Mr. Corfield through his chapters on sewage irrigation, but must conclude with a few words on the evidence afforded on the effect of sewage farming upon public health. In 1855 the Sewage Commissioners stated that near Milan, where a system of submersion is carried on, the population was liable only to the diseases common to a district, where extensive tracts of vegetation are alternately covered with water, and then, when dry, exposed to the action of a hot sun. Professor Christison's evidence with regard to Edinburgh, is, that neither typhus nor enteric fever, dysentery nor cholera are caused by the sewage irrigated fields, and the local medical evidence goes to the same effect. Dr. Cobbold published a tract in 1865, in which he expressed a fear that the spread of entozoic disease would be encouraged by sewage irrigation. He thinks it possible that the eggs of parasites, which infest the blood-vessels with fatal consequences, may be transferred through the fields, to the crops, and to animals and men with most disastrous consequences. There is a danger, not perhaps as Dr. Cobbold stated it, when he feared that the comparatively large eggs of parasites may be transferred through many stages till they reached and destroyed human life, but in the more subtle form of germ propagated disease, which may, all evidence to the contrary notwithstanding, find a congenial soil in sewage-irrigated farms. There are few who could, whether rightly or wrongly, contemplate with composure the employment of the excreta of a cholera-stricken town for purposes of fertilisation.

IQUIQUI AND LA NONA RAILWAY.—This Peruvian line has recently been officially opened for traffic. The line is 34 miles in length, and connects the Port of Iquiqui with La Nona, where there are extensive deposits of nitrate of soda. The Fairlie engine "Tarrapaca" has been running for several weeks, and the resident engineer, Mr. H. S. Eidings, Assoc. Inst. C.E., reports that her performance has given considerable satisfaction.

HIGH PRESSURE MARINE BOILER.

DESIGNED BY MR. HENRY ASHTON, BIRKENHEAD.

(*For Description, see Page 404.*)



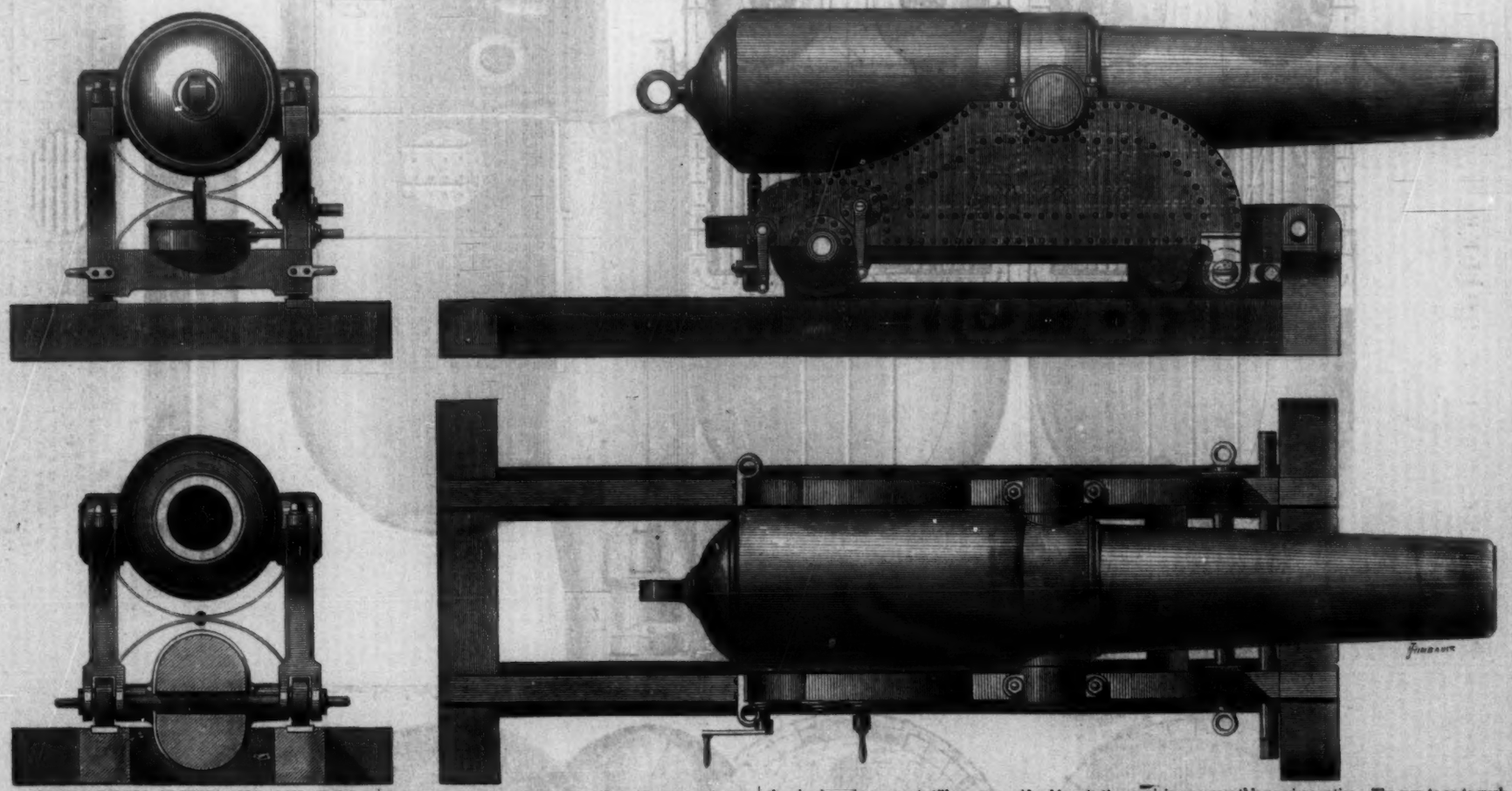
Number of tubes	...	...	840
Length	...	...	6 ft.
Diameter " (outside)	...	...	3 in.
Heating surface of tubes	...	...	3527 square feet
" " furnace, &c.	...	...	642 " "
Total heating surface	...	...	3869 " "
" area of firegrate	...	...	134.6 " "
Sectional area through tubes	...	...	13.2 " "
" " " funnel	...	...	23.7 " "

Working pressure 60 lb. per square inch.

TWELVE-INCH WROUGHT-IRON GUN AND CARRIAGE.

DESIGNED BY CAPTAIN JOHN ERICSSON, AND MOUNTED ON BOARD THE UNITED STATES SCREW STEAMSHIP PRINCETON IN 1843.

(*For Description, see Page* 411.)



NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was again a good attendance on 'Change at Middlesbrough. There was not a great deal of business done, the fact being that no smelter is in a position to accept orders of any importance for immediate delivery. The whole district is heavily sold forward, and months will be required to complete the contracts now on the books. None of the makers will look at orders under 62*s.* 6*d.* for No. 3. The inconvenience occasioned by the scarcity of fuel, to which we referred last week, has been rather less during the past few days. Every effort will be put forth by the colliery owners to keep up an efficient supply in the Cleveland district, where the consumption of coal is so enormous. It is reported that new pits will be sunk near Ferryhill, Durham. The new blast furnaces in course of construction on Tees-side are progressing satisfactorily.

The Finished Iron Trade.—Continued prosperity characterises every branch of the finished iron trade. Puddled bars are in great request. Plates and angle iron, although produced in such large quantities, are scarce, and rails are eagerly inquired for. The quotation for rails is now from 8*l.* to 8*l.* 5*s.*, and a fair share of contracts are being secured to North of England firms.

Engineering.—Generally speaking, every branch of this industry is brisk. The greatest possible activity prevails in the marine department. The demand for marines is more pressing than ever, and engine builders are doing their utmost to keep pace with the shipbuilders, who are launching a large number of steamers.

The Nine Hours' Movement.—In many parts of the country the nine hours' movement still causes considerable agitation. In order that the London engineers and others may know the exact terms on which the Newcastle strike was settled, we append the memorandum agreed to on both sides at the time: Copy of the memorandum submitted by Mr. Philipson, through Sir W. G. Armstrong, to the associated employers.

"October 6, 1871.

"The difference between the masters and the men seems to us to be in substance—when is the overtime to begin, 54 or 57 hours? Suppose, then, the masters concede the 54 hours per week, the men agreeing, after working 54 hours, to work overtime when and to the extent required by the masters. The wages, both as to ordinary wages and overtime, to remain the same in the different factories as prior to the strikes, and to be settled as in Rule 3 (Hawthorn's rules and bye-laws.) The agreement to be for 12 months, with power to either party to determine it at the end of six months, on giving one month's previous notice. The men to go to work on the arrangements now existing in the shops, and the new arrangement to take date from January 1, 1872. Inability to work by reason of accidents to machinery, or where leave of absence granted by the manufacturer, or in cases where a man has, under a pressure of work, worked all the previous night, his absence the next day is not to count against overtime. Holidays also excepted. We recommend this settlement before discussed, with this addition by way of exception.

Signed, JOSEPH COWEN, Jun.
RALPH PARK PHILIPSON."

The Mines.—Throughout Cleveland the mines are working satisfactorily. The extensions in the Gainsbrough district are making rapid progress. It is stated that the ironstone discovered a few weeks ago on the Kirkleatham estate, near Redcar, extends over an area of 300 acres.

HIGH-PRESSURE MARINE BOILERS.

The introduction of high-pressure steam for marine purposes has necessitated a modification in the form of boilers formerly generally used on shipboard; and it may be considered that all marine boilers should now be made as far as possible of circular or spherical parts. The boilers which have been found to answer best since the application of high-pressure steam to marine engines are those with cylindrical shells and furnaces fired at both ends, there being a central flame chamber and return tubes over the furnaces conducting the heated gases to the two ends of the boiler, where they are received in "outside smokeboxes" and conducted to the base of the funnel through "dry uptakes" in which superheaters are sometimes fitted. This class of boiler when well proportioned and carefully made and used is found to answer tolerably well, but it has defects that prevent it from being regarded as a perfect arrangement where the highest degree of economy in space, weight, and fuel are the objects desired to be attained. It occupies, with stokeholes, a large area of base, and the space over boilers being usually filled with dry uptakes, casings, &c., is of little service for other purposes.

The furnace chambers are, moreover, cramped, having but a limited depth from firebars to crown, a condition unfavourable to perfect combustion. The water-line also is so situated that any variation in its height materially affects the cubical capacity of steam space and the horizontal area of water level, and thereby disturbs the equilibrium of circulation and induces priming. The large extent of air heating surface contained in the parts called "outside smokeboxes" and "dry uptakes" is also an objectional feature, as the heat given off by these surfaces is not only useless but injurious. Another serious and costly defect in all horizontal tubular boilers, but especially those working at high pressure, is the unavoidable exposure of that very sensitive part, the junction of the tube ends with the back tube plate to the severe action of the flame entering the tubes. Few marine engineers will dispute the above objections to this type of boiler, but will probably say "we must have high-pressure steam, and must, therefore, be prepared to submit to its attendant inconveniences."

The acknowledged defects to which we have referred have naturally led to attempts to remedy them, and we have from time to time illustrated in our pages types of boilers expressly designed for furnishing a supply of high-pressure steam on shipboard. To these designs we now add another, namely, that of Mr. Henry Ashton, of Birkenhead, whose plans we illustrate on page 402 of the present number. Mr. Ashton's boiler is of the vertical type, and he claims for it the following advantages:

1. Economy in space and weight of at least ¼th or 25 per cent. as compared with the horizontal tubular boilers.

2. Strength; the whole of the external shell, and the greater part of internal work being circular or spherical with the pressure acting on the inside of curve.

3. Durability; the parts of boiler exposed to the severe action of the fire being easily accessible for examining, cleaning, and repairing, and the tube ends (so troublesome in horizontal boilers) not being exposed to the action of the flame.

4. Efficient circulation of water is obtained by providing separate and well defined channels for the upcast and downcast currents.

5. Economy in fuel; the furnace chamber is capacious and there is a good space between bars and crown, it is, therefore, well adapted for converting the gaseous part of the fuel into flame before leaving the furnace; while those heat-wasting appliances called "outside smokeboxes" and "dry uptakes" are not required.

6. Freedom from priming; the well defined system of circulation is in itself an excellent preventive against priming, but besides this, the water level area is not affected by any moderate variation in the height of water, and any water that should pass over with the steam is trapped before reaching the engine.

7. Facility in removing soot and other matter from amongst the tubes is obtained by injecting blasts of superheated steam by suitable arrangements.

8. The heating surface of tubes is of very efficient quality, and better adapted for abstracting the calorie from the flame than an equal area of horizontal tube surface.

How far Mr. Ashton is justified in making these claims our readers will be able to judge for themselves after examining his designs.

The engravings on page 402, show a pair of marine boilers on Mr. Ashton's principle, designed to supply steam to engines of 200 nominal or 1000 indicated horse power. Referring to the figures, it will be seen that the shell of each boiler is a vertical cylinder 10 ft. 7 in. in diameter, and 20 ft. 6 in. high with the top hemispherical or dome-shaped. The interior consists principally of two large chambers, one, *a*, being the fire chamber where the fuel is converted into flame and heated gases, and the other, *b*, *b*, the flame chamber where the heat developed is imparted, to the water through the medium of a large area of efficient heating surface over which the flame is made to pass on its course to the funnel, *q*.

The furnace chamber, *a*, *a*, is in the lower part of boiler; it is a large circular chamber with an arched or dome-shaped top, the central part of the top being depressed and curving downwards, to join a central tube, *g*, about 20 in. diameter which extends downwards to the level of boiler bottom; this tube communicates below the fire bars with an annular water space that surrounds the furnace chamber by means of four strong wrought-iron tubes, *h*, *h*, each 6 in. diameter flanged and rivetted at the ends

The furnace crown presents in plan the appearance of a large cylindrical ring, and has three tubes, *i*, *i*, *i*, respectively 3 ft. 3 in., and 15 in. diameter, leading from it and through which the flame passes to the lower part of the flame chamber which is placed at a distance of about 12 in. above it. The flame chamber is drum-shaped in form, and 6 ft. high, and is placed directly over the furnace chamber with which it communicates by means of the three large tubes just mentioned. These tubes or flame passages vary in size, as we have stated, the largest being at the commencement of the flame traverse. The flame from the other two joins the main current after it has passed over a part of the heating surface, and thus maintains the temperature of the flame current throughout the greater part of its course. The outer shell of flame chamber is circular, while the top and bottom are flat, and form tube plates into which a large number of vertical water tubes, *d*, are fitted.

A circular tube of boiler plate about one-fourth the diameter of the flame chamber is fitted in the centre of the latter between the top and bottom plates; it is securely rivetted to those parts and thus acts as a strong tubular stay. This large central tube forms an upcast circulating shaft between the body of water surrounding the furnace chamber and that over the top of flame chamber, it also affords easy means of access to examine, clean, and repair the parts of boiler exposed to the severe action of the fire. An annular water-space 4½ in. wide surrounds the flame chamber and is intended to act as a down-cast for the water. The flame generated in the furnace enters the flame chamber through the openings in the crown, it then takes a circular horizontal course around the flame chamber coming in contact on its way with the heating surface provided by the vertical water tubes that pass through the chamber, and after traversing a considerable distance over the heating surface presented by these tubes makes its exit through an opening, *o*, in the side of the boiler and passes up between the boilers to the funnel.

The heated gases after leaving the boilers are used to dry or superheat the steam contained in the superheaters which are enclosed in the space between boilers. The steam is taken into the superheater from the upper part of boiler by a large bellmouth pipe, and by the intervention of a deflecting partition is made to travel downwards a considerable distance, then passing under the partition it ascends to the upper part of the superheater and passes through the stop valve to the engine. At the lower part of superheaters a well is provided to collect, and cocks to withdraw, any water that may pass over with the steam.

Soot or other foreign matter lodging amongst the tubes is removed therefrom by injecting blasts of steam through short tubes that lead from the exterior of boiler to the interior of flame chamber. Four fire doors are provided in each boiler for working the fires and two smoke doors for examining or cleaning tubes and flame chamber. Doors are also provided in lower part of funnel for removing soot or other matter deposited there by the action of the steam blast. There is ample room in the steam chamber for cleaning the interior of vertical tubes by the application of suitable tools, or for withdrawing and replacing those tubes if required.

We annex to our engravings on page 402 particulars of the heating surfaces, &c., of the boilers here shown, and we subjoin detailed references to the various figures of our illustration. In the latter, *a* is furnace chamber; *b*, flame chamber; *c*, steam chamber; *d*, vertical water tubes; *e*, central upcast tube; *f*, annular water-space (down-cast); *g*, lower central tube; *h*, lower horizontal circulating tube; *i*, flame passages; *j*, superheaters; *k*, deflecting partitions in superheaters; *l*, flame box crown stays; *m*, flame deflecting partitions; *n*, crown of furnace chamber; *o*, opening for conducting waste gases to funnel; *p*, smoke doors to give access to flame chamber; *q*, funnel; *r*, lower part of funnel; *s*, steam jet pipes for cleaning soot from tubes; *t*, man doors; *u*, mud doors; *v*, fire doors; *w*, funnel doors; *x*, blow-off cocks; *y*, feed cocks; *z*, firebars.

COTTON GINS.

Under the direction of Dr. Forbes Watson, on the part of the Government of India, a very important series of trials of cotton gins is now being conducted at Manchester, and promises to lead to practical results of great value.

The term "cotton gin" is applied to the mechanical contrivance, of whatever kind it may be, that is employed to separate the fibre of the cotton from the seed which it surrounds, and the principle common to all gins is that the fibre shall be in some way drawn through an aperture which is too small to allow the seed to pass. It is important to the conduct of manufacturing operations, such as carding and spinning, that the fibres should be torn cleanly from the seed, so that they may have no fragments of husk adhering to them; while it is equally important, as regards the strength of the fabric to be manufactured, that they should not be broken or unduly strained in the process. A perfect gin, therefore, would deliver clean and unbroken seed on the one side and uninjured cotton fibre on the other. It is a matter of obvious economy that the work of ginning should be carried on by the cotton-grower, who is generally unable to command any high degree of manufacturing skill. On this account gins should be simple in their construction, not liable to many accidents, easily repaired, and capable of being worked by common labourers.

The precise mechanical conditions with which the gin is required to deal vary, within considerable limits, according to the kind of cotton for which it is to be used. Not only are there great differences in respect of the length and fineness of the fibre—differences which affect, of course, the facility with which it can be acted upon by rollers or other contrivances—but there are also great differences in the size of the seed and in the firmness with which the fibre is attached to it. In American cotton, for example, the seed is fully twice as large as in many Indian varieties, and in both the American and the Indian the seed can only be torn out with a considerable fluff attached to it, the adhesion of the fibre to the husk being stronger than the fibre itself. In Egyptian cotton, on the other hand, the seed shells out easily, with a smooth coat, and the fibre remains unbroken. It follows that a gin which is very serviceable for one variety of cotton may be very ill-adapted for another, and hence there are considerable differences between the forms that have found most favour in different parts of the world.

The attention of the Government of India has long been directed to cotton cultivation as a most promising field of native industry, and a factory has been established at Dharwar for the supply of gins to native growers. It is manifest, however, that the quality of the product sent over to this country is largely dependent upon the perfect adaptation of the gin to the particular variety of cotton for which it is to be employed, and hence Dr. Forbes Watson, whose unquenchable zeal for the promotion of the prosperity of India has been so often manifested, suggested to the Secretary of State in Council, that a series of experiments should be undertaken by which the precise value of each kind of gin should be determined with absolute certainty. Hence the present trials, in which all the exactitude of physical science is being brought to bear upon a commercial and manufacturing question. A circular was sent in due course to manufacturers, and 17 gins were entered for competition. Instructions were sent to the Government factory at Dharwar to send two gins, and Dr. Forbes Watson, the superintendent of the factory, came himself in charge of them. The total number at the commencement of the trials was therefore 19; but three of these have been already withdrawn from competition.

The points to be determined for each gin, and in respect of each of the principal varieties of cotton, are:

1. The speed of working, as tested by the time in which a given quantity of seed cotton can be ginned.

2. The facility of working, as tested by the quantity of power consumed in the operation.

3. The quality of working, as tested by the condition of the ginned fibre and the separated seed respectively.

In order that the results of the experiments might not only serve for the guidance of the Indian Government, but might also be accepted as absolutely conclusive alike by cotton growers and by gin manufacturers, it has been necessary to exercise a good deal of ingenuity in framing regulations to exclude the possibility of any kind of error or deception. The seed cotton required has been provided by Government, and consists of the following varieties, viz., Broach, Dhollerah, Candeish, Madras (two kinds), Dharwar American (grown at Dharwar from American seed), American Uplands, and Egyptian, together with smaller quantities of Sea Island and Brasilian. Part of the space appropriated to the trials has been set aside as a mixing room, in which the contents of a sufficient number of bales of each variety have been thoroughly intermixed, and then weighed out into bags, each holding 100 lb. or 50 lb., so as to avoid errors from accidental differences in the quality of different bales. A large adjoining room contains the gins, each railed off within a separate enclosure, under a lock and key, to which no one but the proprietor or his agents and workpeople have right of access. On either side of the room are compartments, some for holding the bags of seed cotton prepared as described, the others for the results of ginning. The latter are locked by two locks, one key being in the possession of Dr. Forbes Watson, the other in that of the proprietor of the gin, the produce of which is stored there, so that no tampering with the results is possible. When a trial commences, a bag of seed cotton, mixed as described, is served out to the persons in charge of the gin, and the time of starting is noted by themselves, and also by a Government agent. The time of completion is noted in the same way, and the resulting fibre and seed are stored in two bags. To each bag a ticket is affixed, stating the number of the gin, and the number of the experiment, and these bags are at once locked up as described, while further trials are being proceeded with.

For each gin a separate record book is kept, the pages of which contain forms to be filled up by notes of the details of each experiment—that is, by the time of starting and completion, the quantity and description of seed cotton dealt with, and the weight of seed and of fibre resulting from the process. The page contains also a space for remarks by Dr. Forbes Watson, in which he records every circumstance by which the results of any experiment may have been affected, and also any damage or accident, and any alteration or repair, which the gin may have undergone at the hands of those in charge of it. They do exactly what they like within their own enclosure, but everything they do is written down. At the close of each day the person in charge of each gin is required to sign the official record of its proceedings, a space being also allotted to him in which he may make any remarks he thinks fit, or offer any explanation of what he finds stated. The precise correctness of the official record is thus in every case admitted by the responsible agent of the proprietor of each gin.

The facility of working depends, of course, upon two factors—the power necessary to keep the gin in movement, and the power necessary to supply it with seed cotton.

For the determination of the former of these factors recourse has been had to the dynamometer of Mr. Amos, which has been used for so many years, under his direction, in the various experiments instituted by the Royal Agricultural Society. It consists of two wheels, one of which receives a driving band from the main shafting, while the other sends a driving band to the machine actually at work, and an apparatus registers, on two sets of dials, the difference between the force received by the instrument and the force actually exerted. The number of foot-pounds required to drive each gin is thus ascertained with minute accuracy; and this department of the inquiry has been controlled by Mr. Amos himself, who has remained for many hours of each day in heated rooms, and in an atmosphere loaded with cotton dust, in order that there may be no doubt about the correctness of the conclusions. The supply of seed cotton to the gins is necessarily a matter of hand labour. In some a mechanical feeder has been introduced, but even this, of course, requires to be fed; and hand-feeding of the machine itself may be said to be the rule. Dr. Forbes Watson, therefore, writes down for each experiment the number of persons employed about the gin to produce the stated results, and on this head there is remarkable evidence of the value of the official record, controlled by the signature and remarks of the authorised agent. Dr. Forbes Watson, for example, saw and wrote down that two men were employed about a certain gin—one, who never left his post, to feed the acting machinery, another to supply the actual feeder with seed cotton from an adjacent heap. The agent admits the accuracy of the statement, but adds that one man can supply seed cotton to the

feeders of three gins; so that, while two men are required for one gin, only four men would be required for three.

The third point, the quality of the work done, is one which has hitherto always rested upon opinion, as represented by the valuations of products by skilled brokers. To this tribunal the first appeal will now be made, although it is probable that some other tests may also ultimately be employed. The Liverpool Cotton Brokers' Association and the Cotton Supply Association have undertaken to value the cotton and seed turned out during the trials, and it has, therefore, been necessary to devise a means by which every sample can be identified when necessary, but which shall render it impossible for any to be identified until the proper time arrives. For this purpose Dr. Watson has provided a series of cards about a foot square. Each card is divided by lines into twelve smaller squares, and each square has a number printed upon it. The numbers range from 1000 upwards, and are the same in every square of any single card; but no two cards are alike. Each card is covered over by a sheet of paper rendered perfectly opaque by an admixture of China clay, and gummed to the card along the lines between the squares, so that each card can be cut into its component squares without disclosing its concealed number, which is only to be discovered by tearing off the paper from the surface. At the close of each day the bags containing the fibre and seed produced during that day are all brought up to be finally labelled. Each experiment, as a rule, produces two bags—one of fibre, one of seed. The weight of each bag is first carefully taken in the presence of every one interested, and recorded on the ticket attached to it. Dr. Forbes Watson then takes a card at random from the heap, cuts two squares from it, and receives the two tickets in exchange for them. The two squares, with their numbers still concealed, are then sewn to the bags, a handful or two of seed and of cotton is taken out to render identification by weight impossible, and the bags are securely tied and sealed with a lead seal and the stamp of the India Office. The original identifying tickets, the remaining squares of the numbered card, and a sample of the cotton are all put together into a large envelope and closely gummed down. These envelopes are deposited with one of the Liverpool banks, only to be given up at the joint requisition of Dr. Forbes Watson, of the representative of the Cotton Supply Association, and of the representatives of the competing manufacturers.

The result will be that a broker will be called upon to value a sample of cotton contained in a bag bearing a covered number, only to be revealed at the time of valuation. He will express his opinion, say, of sample No. 1044. When all the samples have been examined, it will be found that there is a bag of seed numbered 1044, and also a bag of fibre. In one of the envelopes at the bank will be found the ten remaining numbers 1044, the tickets identifying the samples as the result of number x experiment with number x gin, and a sample of the produce as an additional element conducing to the certainty of the recognition.

The gins entered for competition may be arranged in three principal classes, as roller gins, knife and roller gins, and saw gins.

The only example of a pure roller gin is M. Chaufourier's "Churka," an adaptation of the native cotton gin or "churka" of India. It consists of two steel rollers, each about ¼in. in diameter, spirally grooved to increase their hold on the fibre. The seed cotton is brought up to the rollers on an endless band. The interval between the rollers is too narrow for seeds to pass, and their circumference is too small for seeds to be grasped and crushed between them. The seeds are, therefore, simply held back, while the fibre is carried onwards, and they fall into a receptacle when they are completely detached. The weak points of the instrument are that the rollers are liable to become heated, and that their small size renders it necessary to have them very short, or to interrupt their continuity by many points of bearing. M. Chaufourier has designed an ingenious fan by which to keep his rollers cool, and the difficulty about many bearings is one that he hopes soon to overcome.

The knife and roller gins in competition are eleven in number. They all depend on what is called the Macarthy roller, a spindle usually of iron, covered with closely-packed rings of hard leather, scored on the surface by lines forming lozenge-shaped divisions, and producing a sort of roughness, which assists in dragging the fibre in the direction of the motion. These Macarthy rollers are all in relation with some form of blunt knife, the edge of which drives back the seed as the fibre is drawn forward. In some forms the knife is a single blade, in others there are two blades, one behind the other. In one form the two blades meet like jaws. In others the continuity of the blade is broken in various ways. Circular knives are placed obliquely upon a spindle, or short knives are arranged at intervals on projecting arms. In one a two-edged knife is made to play to and fro between two rollers, and thus to accomplish more work in a given bulk of machine. But in all the principle is the same, that the knife prevents the seed from following the fibre as the latter is drawn away.

The saw gins are of American origin, and are believed to be best adapted for American cotton. Three examples are at work, one made for American planters by Messrs. Dobson and Barlow, the other two from the Government factory at Dharwar. The saw gin consists essentially of an iron plate cut into alternate bars and interspaces like those of a grid-iron, and with the blades of circular saws projecting through the interspaces. As the saws revolve, their teeth drag the fibres with them, and the bars hold back the seeds from following. On the other side, a spindle carrying brushes revolves behind the saws, and clears their teeth of the entangled fibre, which, thus set free, is blown, by the current of air produced by the machine, into a room or space enclosed to receive it. Saw gins have been accused of lacerating the fibre, and it is considered necessary that the intervals between the teeth should be rounded off, and not left sharply angular at the apex.

A modified form of saw gin, called "toothed roller gin" by Messrs. Garnett, the makers, presents many peculiarities of interest. Its teeth are cut in the edge of a piece of flattened steel wire, which is then wound spirally round a roller, and affords great facilities for rapid renewal in case of wear or breakage. The roller is fed from above by another roller, grooved in the direction of its axis; and the machine admits of being equally well made in any size, so that it may be worked either by one man or by steam or water power.

The trials commenced on the 28th of November, and it is anticipated that they will be continued until the 23rd of the present month. It would, of course, be premature to express any opinion about the probable results, as in due time the whole of the facts brought out will be published on official authority, and much at present remains unknown. One point of importance must be eventually determined in India itself, and that is how far the experiments made here with comparatively dry and hard imported cotton will apply to the crop in a more green and fresh state. Except for this, there can be no doubt that the present trials, and a supplementary series to be undertaken in January, will teach the precise value and the particular defects of every form of gin now in use, will exhibit to manufacturers alike the weak and the strong points of their various contrivances, and, even apart from the improvements to which they may be expected to lead, will enable every grower of cotton to obtain the gin that is best adapted to the peculiarities of his crop and to the demands of his market. Even for those who have no special interest in cotton the trials are well worth seeing, if only on account of the scrupulous accuracy with which they are conducted, and of the care with which all sources of error seem to be shut out. They are held daily at the mill of Messrs. Percival and Patteson, Jersey-street, Ancoats, Manchester, and, although there is not space for many visitors at a time, no one who has any reasonable claim to admission will be excluded.—*Times*.

NAYLOR'S RAILWAY BRAKE.

YESTERDAY week, the 14th inst., a trial was made on the Sevenoaks branch of the London, Chatham, and Dover Railway with a set of Naylor's continuous brakes, in the presence of a number of gentlemen interested in railways. The train consisted of an engine, its tender, and a van without a brake, and four carriages with Mr. Naylor's continuous brakes applied to them. The day was damp and somewhat unfavourable, but notwithstanding this, a number of interesting experiments were carried out. For a long time it has been feared in many quarters that if a set of brakes was applied nearly simultaneously on a train travelling at a high speed, it might create an unpleasant sensation to the passengers. The trials made yesterday week, however, showed that if the application of the brakes is duly regulated, as is the case with Mr. Naylor's system, no such effect is produced. Thus with the experimental train travelling at 57 miles per hour down an incline of 1 in 101, the driver on the engine applied the set of continuous brakes, shut off his steam (but did not reverse his engine), while his fireman applied the tender brake, yet, even with this suddenly-applied retarding force, no unpleasant sensation was experienced by any one in any part of the train. Several gentlemen rode in the carriages that were fitted with the continuous brakes, but owing to the peculiar arrangements of the brake-blocks the carriages were found to ride as easily upon their springs after the brakes were applied as they had done before the latter were let on. We subjoin particulars of the trials made arranged in a tabular form.

Results Obtained with Naylor's Patent Continuous Brake on the Sevenoaks Branch; London, Chatham, and Dover Railway, December 14, 1871.

No.	Gradients.	Speed in miles per hour.	Distance travelled after applying brakes and shutting off steam.	Time required to pull up.
				seconds.
1	1 in 101 down	53	Distance not measured	55
2	do.	49	480 yards	38
3	1 in 101, up not quite all the way, partly down an incline	36	212 „	20
4	1 in 101 down	57	750 „	60
5	Level	50	700 „	

Nos. 1 and 2 going to Sevenoaks, Nos. 3, 4, and 5 returning.

Train consisted of five carriages (four of which are fitted with the patent brakes) drawn by an engine with tender attached, the latter only fitted with a screw brake worked by hand. The tender and patent brakes were applied in each case. Rails in a very slippery state during the whole performance.

Mr. Naylor has four different methods of letting his brakes on and of taking them off again, these methods being adapted to various requirements of different classes of railway trains, or different climate or country. In every case the brakes are let on by slackening out the continuous chain, and the variations in the plans consist in the different methods adopted for tightening this chain, and thus taking the brakes off. One mode of doing this is by taking advantage of the direct action of the steam supplied from the boiler of the engine; a second is by the direct action of water or compressed air supplied by pumps fixed in the van; a third is by means of a crab winch with a fusee barrel, operated by means of a roller which brought into contact with a boss upon the axle of the van; while the fourth is by using a small crab with a fusee turned by hand by the guard.

Mr. Naylor has, through his agents, Messrs. Budd and Holt, made offers to a number of the different railway companies to be allowed to fit a set of his continuous brakes on one of any of their trains. He proposes to do so at his own expense and risk, and if they are not in every way satisfactory, he undertakes to remove them again without the railway companies incurring any risk of any loss. In view of making an application in this way, he has already prepared a number of the standard details of his brakes, such as crabs, &c. We have examined the drawings of Mr. Naylor's various arrangements, and we considered that they possess very great promise. We may add, in conclusion, that we hope shortly to be able to illustrate in complete detail the various arrangements which have been designed by Mr. Naylor, and we shall then have more to say respecting their practical features.

NOTES FROM PARIS.

PARIS, Dec. 18, 1871.

THE SOCIETY OF CIVIL ENGINEERS.

THE Society of Civil Engineers on the 15th of December made its new elections. M. Muller will be president for 1872; this gentleman is a professor of the Central School, architect of the workmen's town at Mulhouse, manager of the Ivry Chemical Works, and is well known by many large works of construction.

WARMING APPARATUS.

In France, where fuel is more costly than in England, more care is taken in utilising it, and in reducing its consumption. This necessity has, as a matter of course, brought about the invention of a great number of stoves, of grates, of heaters, &c., all more or less ingenious or efficacious.

The grate is doubtless the least economic of all heating apparatus, but it conforms better to general taste, and it is therefore generally employed in houses. Many inventors have applied themselves to improve them, preserving their exterior appearance. Amongst the arrangements designed with this object that produced by M. Foudet, and which is already old, has extended greatly in use, and gives good results. It is a heating grate—that is to say, that it presents an open stove, heating by radiation, and it comprises an apparatus by which a certain quantity of cold air, either from the apartment or from the outside, is warmed by the stove and by the gases disengaged from it are sent into the room by convenient openings.

The Cordier system is an improvement on that of M. Foudet. It is composed of a double row of cast-iron tubes of a square section; joining two air-boxes also of cast iron, the lower one receiving the cold air, which passes into the upper one, and becomes heated, and is distributed. The apparatus is placed in the bottom of the fireplace in an inclined position, and, partly covering the stove, it reduces the horizontal section of the gas passage, so that the gases pass through, and spread around the tubes. The whole apparatus is hinged, so that it can be raised against the vertical side of the hearth, and frees the whole area for cleaning, laying the fire, &c. The grate receives the coke or coal, and the whole is arranged in such a manner that the fuel touches neither the cold air-box nor the tubes, so that the apparatus is preserved from destruction. Lastly, the whole is arranged in such a way that the boxes and tubes can be easily cleaned.

EXPERIMENTAL LABORATORY AND WORKSHOP.

The School des Ponts et Chaussées has just constructed, at No. 3 Avenue d'Iéna, an annexe which is scarcely yet completed, and which is intended for the following service: an experimental laboratory and workshop, destined to facilitate practical construction and the progress of constructive science, in furnishing to the school professors, and to other engineers, the means of investigations and experiments, which each of them may be unable to obtain single-handed: the collection and classification of models which, from their weight, or mode of working, cannot be placed in the galleries of the school; the organisation of a central depôt for machines and appliances necessary to the work of the engineers of the school; the installation of halls for examinations, and séances for the Council and the Commissioners.

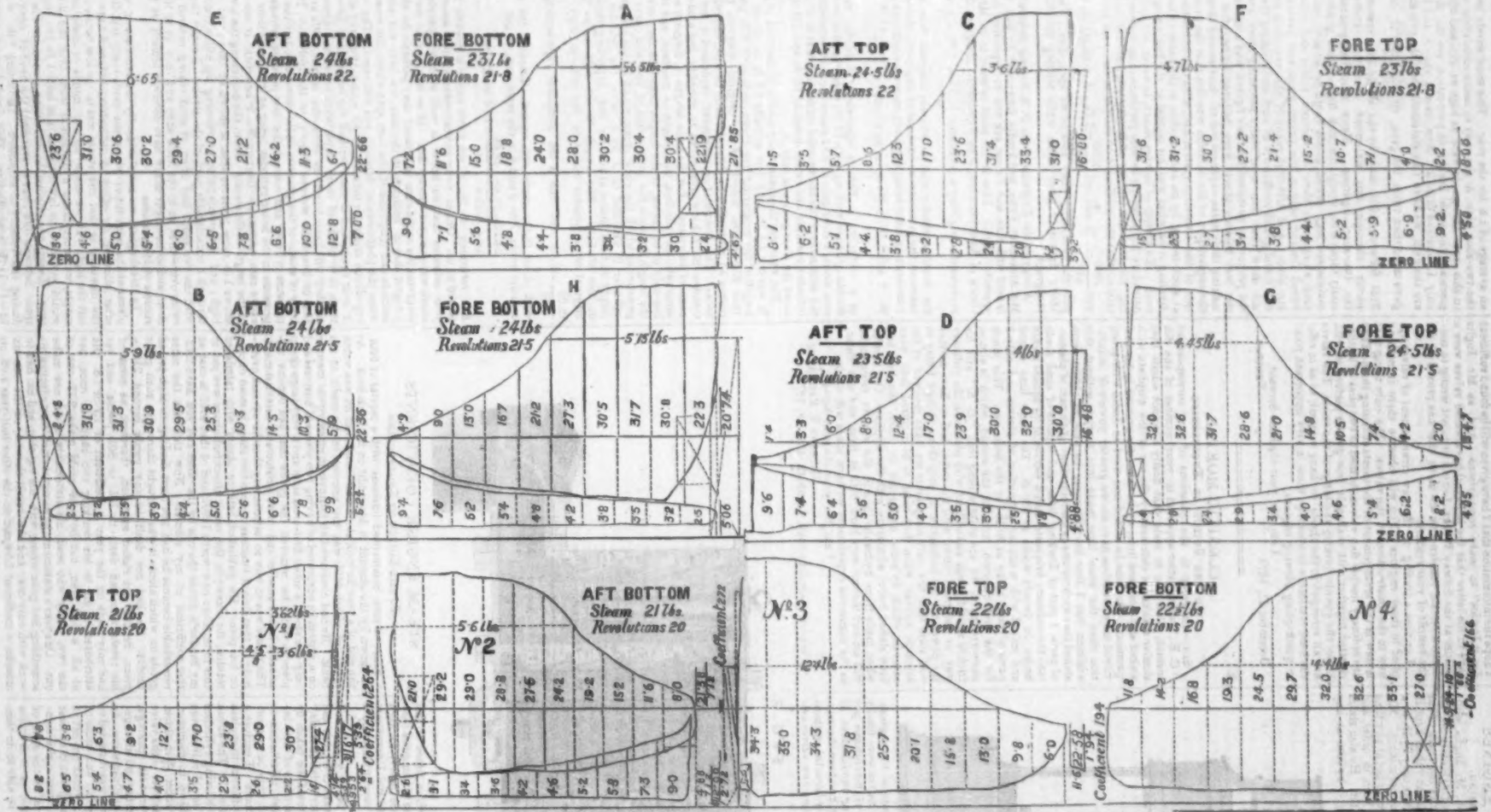
We find in the "Annales des Ponts et Chaussées" the detailed particulars of this new scientific establishment. The workshop contains a forge, tools, lathes, planes, drills, &c., mill plant, and air furnace. The experiment room contains a Hugon gas engine of 1 horse power. This little machine, actuated by a gas jet, is especially adapted to a place where the amount of work is constantly changing and is subjected to various interruptions. The small amount of shafting driven by the engine extends into the workshops when it moves the tools. In the same room there is a grinding mill for cements, pozzolani, &c., a circular saw for wood, an optician's lathe, and an air-pump. Shafting in the same room drives also all the necessary experimental machines. An hydraulic press for testing stones, bricks, and other materials is also there, as well as an apparatus for testing the strength of cement. Other instruments for measuring the strength of metals will be placed there. A steam engine of 8 horse power serves to drive some other apparatus located in the court-pumps, pile-driving machines, &c. A basin 18 ft. deep will give facilities for testing the pumps, &c. Canals, reservoirs, and sluices are conveniently arranged for the study of hydraulic questions.

In another building we find a test kiln for lime and bricks, a muffle furnace heated by heavy coal oil, a sand bath, an asphalte boiler, and an enameller's stove. Precise balances, a gas exhauster, a gas meter, a spectroscope, a saccharometer, a mercury bath, eudiometers, a Ruhmkorff coil, a calorimeter, serve for precise experiments.

We may add to this list, instruments for registering the speed and direction of the wind, barometers, rain gauges, and to these will be added many others for observatory investigation. The laboratory already existing at the school has long rendered precious service to engineers and manufacturers; the new establishment will permit the development already observed in a far extended manner. During the past six years the laboratory has effected gratuitously for students and for engineers more than 1000 experiments yearly.

INDICATOR DIAGRAMS FROM THE PADDLE STEAMSHIP "BOGOTA."

(See Mr. Gray's letter on "Steam Engine Coefficients" on opposite Page.)



NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD Wednesday.

New "Limited" Undertaking at Sheffield.—I am informed on the best authority that a new limited liability company is in course of formation at Sheffield with the object of working a recently obtained patent for a certain specialty which is in great and general demand, both in this country and throughout the whole civilised world. I am not at present at liberty to go into details before the scheme is fairly launched before the public, but from the names which are in business circles, mentioned as being connected with the enterprise there can be but little doubt of its success. It is understood that a site suitable for carrying on the business has been secured.

The South Yorkshire Miners' Demands.—On Saturday last a circular, signed on behalf of the South Yorkshire Miners' Association, by Messrs. J. Normansell and P. Casey, was issued to the colliery proprietors in the district, asking for a further advance of five per cent. on the present wages of the miners and pitmen. The circular states that the trade being now so exceedingly prosperous, and the price of provisions, &c., unusually high, the men deem themselves insufficiently paid, and therefore ask for the increase, despite the fact that on October the 1st last, they obtained a five per cent. advance. A number of the colliery proprietors have held a meeting at Wakefield, and have resolved to wait in order to see what action the men will take on the date given, January 1st, 1872. It is feared that disputes, and probably strikes, will arise in more than one instance. The men employed at the Duke of Norfolk's collieries, near Sheffield, have made demands even higher still, and ask for a reply on or before the 22nd inst.

New Blast Furnaces at, or near, Nottingham.—It is stated that several blast furnaces are about to be erected in the vicinity of Nottingham, and that the person who has the matter in hand is a Sheffield gentleman well known in the trade. The Northamptonshire and Leicestershire ores will probably be used in case the enterprise is proceeded with.

Meeting of Messrs. W. Charles and Co.'s Creditors at Sheffield.—A meeting of the trade creditors of Messrs. Charles and Co., Sheffield, was held to-day in the Cutlers' Hall, Sheffield. After some discussion on various technical points a committee of five gentlemen was appointed to inspect and carry on the concern until January 18, 1872, until which date the meeting was adjourned. Mr. Allott continues receiver in the estate.

Additions and Alterations at Elsecar.—Messrs. Dawes, of the Milton and Elsecar Iron Works, South Yorkshire, has just put down two new iron-cased furnaces, one of which has been put in blast. New machinery of magnitude has been added, and a gas furnace on Siemens's principle fixed for working the puddling and heating furnaces. The firm have now four furnaces at Elsecar, two at Milton, three at Frodingham, North Lincolnshire, in work, and four in course of construction, and four at Derby, in Derbyshire. They also work several foundries, mills, &c., and have bored at great cost to a valuable seam of coal at Hales Owen, Warwickshire. At their Elsecar Works they have just put down a White's patent blooming mill, which is worked by a beam engine of 120 horse power.

Castleford Water Works.—The necessary works, &c., for the supply of Castleford with water are about to be commenced, and, when once put in hand, will be prosecuted vigorously.

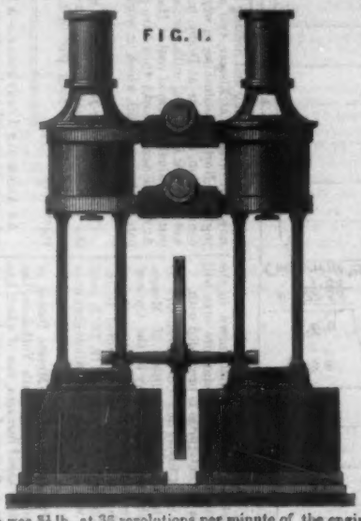
AN AMERICAN LIGHTHOUSE.—A lighthouse costing 76,000 dols. is to be erected at the entrance to the harbour of Cleveland, Ohio.

VALVES FOR BLOWING ENGINES.

TO THE EDITOR OF ENGINEERING.

SIR,—In your impression of the 8th inst., Mr. Inglis, while admitting that the valves of the blowing cylinders at the Solway Iron Works proved a failure, denies the truth of the statement I have made regarding the time the valves kept in order, also that the pressure of the blast was only 2½ lb. at a speed of the engines of 48 to 50 revolutions per minute. Mr. Inglis in his letter states that "the valves were not at any time very tight;" then they never could have been in order, and would naturally get worse instead of better. He also states that the lowest pressure of blast observed by him at any

FIG. 1.



time was 3½ lb. at 36 revolutions per minute of the engines, also that two or three weeks before the valves were finally removed the speed of the engines was 44 revolutions per minute, and the blast pressure 4½ lb., blowing two furnaces. If what Mr. Inglis states, or anything like it, had been the case, certainly the Solway Company would never have taken them off, and been at the great expense of applying new valves and seats. I had several opportunities at various times of examining the engines and valves during the six months they were at work, and I never saw the pressure nearly so high as the lowest pressure Mr. Inglis has seen, and I never saw the engines going at a less speed than 48 revolutions, and I have seen them at 52.

Your correspondent "Justice" says, "Many a good and really useful invention is condemned for want of a trial, and a still greater number for want of a proper trial or trials." This is all quite true, but great care should be taken by engineers when and where to make these trials of new inventions. It is certainly, to say the least, injudicious to apply them where, if they failed, it could only be at enormous disadvantage and expense to their clients. I enclose a sketch of the engine, which I hope will be sufficient to explain how it is "coupled, direct-acting, and vertical." The steam cylinders are 52 in. in diameter, and the blowing cylinders 75 in. in diameter, working 4 ft. stroke. The old valves were composed of iron tubes, 6 ft. 10 in. long, 2½ in. in diameter, and about ⅞ in. thick, covered with india-rubber, ⅛ in. thick, shrunk over the tube, making the outside diameter of the valve 2¾ inf. Each valve weighed 16½ lb., and covered six openings, about 12 in. long by 1¼ in. broad. The number and arrangement of the valves is exactly as shown in your illustration. As to the lift of the valves, I don't know what it was intended to be, but in practice it varied from ¼ in. to ½ in., and some of them seemed to be glued to their seats, and would not lift at all. Apart from the nature of the valves, I would at least presume that Messrs. Hargreaves and Co. were quite competent to proportion the areas of the ports to the areas of the cylinders, and the speed of the engines, as it is quite immaterial what kind of valves you use to be able to do this. I hope the information that I have given will be found sufficient for "Justice" to make comparisons. And, as Mr. Inglis says in his letter that the india-rubber covered valves were a failure at the Solway Works, I think it is not wrong to condemn a certain construction of valve that has proved so, for the benefit of your readers.

I enclose a tracing of the new arrangement of valves applied to these engines. You will observe there is nothing new in the construction of the valves. The only thing that is new is the arrangement of the chests enclosing them. They are ordinary leather flap valves, formed of two plies of leather rivetted together with malleable iron guards perforated with holes, the guards forming the hinge of the valve. The valves are all arranged in the chests to hang vertical, so as to offer the least resistance in opening them, a very important point in quick-going blowing engines.

I am, Sir, your obedient Servant,

December 11, 1871. VERITAS.

SELENITIC MORTAR.

TO THE EDITOR OF ENGINEERING.

SIR,—In reply to the questions of your correspondent "C. E.," whose letter appeared in your number of the 8th instant, allow me to state that firstly I cannot admit that similar results are obtained by the use of the sulphate with slaked and unslaked lime, as he takes for granted in his first question. The lime he slaked and used in India with green vitriol may doubtless have shown greater powers of induration than the same lime made into mortar without this addition, but I fear he will never be able to obtain from slaked lime such results as the following: ½th part of plaster-of-paris, 1 part of Dorking lime, and 6 parts of sand made into the ordinary briquette with a section of 2½ square inches broke in twenty weeks at 320 lb. The same lime slaked and mixed with a similar proportion of plaster and only 3 parts of sand broke at 30 lb. at the same age. This much for the first question, and for the second, which is almost answered by it, we are quite willing that "C. E." and his friends should gauge slaked lime with plaster in the ordinary way, or use green vitriol with the same, and we have neither the power nor the inclination to stop them, though I may as well state that the only complaints we have received of the selenitic mortar, when they came to be inquired into, were cases in which, by some negligence or other, the lime had been slaked before admixture with the sulphate. Our mortar when made from hydraulic lime in the way we recommend will set and become very hard both in fresh and salt water, as the numerous experiments we have made will testify.

I am, Sir, your obedient Servant,

GILBERT R. REDGRAVE.

6, Wharf, Belvidere-road, Lambeth, Dec. 18, 1871.

FIG. 2.

STEAM ENGINE COEFFICIENTS.

TO THE EDITOR OF ENGINEERING.

SIR,—A man commenced business with a capital of 500*l.* as shown by the amount to his credit on bank book. At the end of a year he took stock and found that he was worth 1200*l.*, of which 440*l.* was the amount to his credit at the bank. He had conducted his business in an energetic manner on a system he advocated of having two places of business and only one stock, a small first-class shop and a very large cheap place to which he removed the goods that had become unsaleable in the smaller and more aristocratic establishment. The result was to him so satisfactory that he advised everybody in that line of business to open two shops instead of one, on his plan. He published balance sheets with tabulated results; for example, the result described above was put in this form, I am now worth 1200*l.* and of that 440*l.* is cash at my banker's, divide the one by the other and you have 2.72, the coefficient of my success. Now this was the more remarkable because he had not been dealing in high priced goods on which alone it was thought there was such great profits. He had not dealt in any goods beyond 21*l.* a piece, he had not risked so much, therefore, as some of his rivals who had dealt in 70*l.* or 80*l.* pieces, and yet had only made on the year a coefficient of 1.7 or 1.8. He attributed it all to his working two shops at once, not at all a bad plan, but how he could make 2.72 out of the two, many who read his statements could not make out. One year's statement, however, seemed very conclusive; something had gone wrong with his big shop and he had to work with only one, and the result showed, on the one six months, a coefficient 1.94 and on the other half-year 1.66, on an average of 1.8 for the year. This must surely prove that the two-shop plan is the way to make money, for although in this year the goods were as high as 22*l.* and 23*l.* 10*s.* a piece and the profit higher in proportion, yet the result was only 1.8 instead of 2.72. Now as it is the .8 and 1.72 that are the gain, we have this statement that the two-shop plan gave more than twice the gain, viz., $\frac{1.72}{.8} = 2.15$, or made 215*l.* for every 100*l.* made by the single shop system. And partly through this statement everybody rushed into the two-shop business. Many were disappointed, especially those who would not risk high priced goods. Some maintained high priced goods could be all sold out in one shop along with those at reduced prices and others preferred dealing only in low priced goods and having a good big shop. And although many of the two-shop advocates still found grand coefficients at each stock-taking they could not show that they were really becoming more wealthy in the proportion promised by their figures, and some who had the best balance sheets were believed to be after all not making their extra expenses out of their second shop. And the explanation of the delusion was this that the great advocate of the two-shop system had always divided his capital at stock-taking by his balance then at the banker's instead of dividing it by what was his capital at the beginning of the year. His system of balance sheets, however, not only found defenders, but after his decease partisans came forward claiming for him the honour of having originated it, and maintaining that the coefficient of success in the year referred to was $\frac{1200}{440} = 2.72$ and not $\frac{1200}{560} = 2.14$. I certainly do not dispute the authorship they seek to fix upon him. Carry the above figures in your mind while reading the following paragraph.

A copy of the diagrams of the P. S. Bogota referred to by Mr. Alexander Elder, and kindly forwarded by him to you, is sent with this, and I must ask you to reproduce it. [See opposite page.] This is the sheet referred to by Mr. Lewis Ulrick in ENGINEERING, 10th November. Diagram No. 3 is represented as giving a coefficient $\frac{12.00}{4.40} = 2.72$, the result of the double cylinder system, whereas diagram Nos. 3 and 4 taken on the same day an example of single cylinder working (the large cylinder being disabled), shown a coefficient 1.94 on No. 3 and 1.66 on No 4, on an average of $\frac{1.94+1.66}{2} = 1.8$ as a coefficient. This is equivalent to saying that the double cylinder working with 21 lb. pressure gave by expansion alone, a clear gain of 1.72 times the work represented by the admission of the unexpanded steam, and that in the single cylinder example and with steam of 22 lb. and 23½ lb. pressures the clear gain was only .8.

But what was the steam really used to do the work in No. 2? It was not 4.4 lb. only but actually 5.6 lb. as shown by the length of the measuring line drawn on it at 27.3 lb. pressure. This 27.3 is the length of the original diagram in half inches 9.1 multiplied by 3 lb., the ratio between the cylinders' areas. This system of measurement, explained in my letter, October 22, I have introduced to simplify the admeasurement of diagrams. For the same length of diagram and the same ratio of cylinders, the height is constant, and the line has only to be drawn, or the height ticked on the curve, and the length between the intersection of line and curve is the pressure at which the whole steam would fill the low-pressure cylinder if admitted to it by a valve, the cylinder being empty and the piston at the far end, supposing there was no loss of heat. The length is 5.6 half inches in the original or 5.6 quarter inches in the reduced copy. Now $\frac{12.00}{5.60} = 2.14$, and this is the coefficient representing the work done if the cards are correct. Treating the single cylinder cards, Nos. 3 and 4 in the same way, we get

$$\frac{24.10+22.58}{14.4+12.4} = \frac{46.68}{26.8} = 1.74 \text{ coefficient.}$$

But returning to No. 2, we have surely a miracle represented to us. One of your correspondents lately asserted in your columns that he knew as well as other people how much water would run up hill. If he happens to see these diagrams his confidence in himself may perhaps be shaken. I regret that in addition to the date, we have not also the latitude and longitude of the very spot where the vessel was when the phenomenon depicted was witnessed. The eclipse expedition might be induced to go round that way and try it over again, and if they verified the report here presented to us, it would be of more importance to us engineers than all they will have to tell us about the eclipse. We are told that on board the steamer Bogota, on the 16th May, 1860, a body of steam of the pressure 8¼ lb. above zero left the high-pressure cylinder and entered the low-pressure cylinder, the pressure in the latter cylinder being at the same time 9½ lb. above zero, as witness diagram No. 2 herewith at one-tenth of the length of the stroke. From the beginning the low card shows 1 lb. more pressure than is shown at that point in the high; and this overlapping or running up hill is continued through a considerable part of the stroke. I doubt the man with the two shops had often, at stock-taking, entered goods twice over—first, as in the little shop and then as in the big shop, and so he might easily have deceived himself as to the success of his business.

In this diagram we have evidently the same steam in two places at the same time; where the cards really lap, that is, after allowing for effect of connecting rod, as I have done, the meaning is that the steam was in the low before it had left the high. If we make up our minds to disbelieve in magic, we must make a deduction from even the 2.14; I would say that the low diagram is at least 1 lb. too high all over. Lapping is impossible, and there should be instead a space between the lines to represent the head of steam producing the velocity of admission. Deducting 1 lb., we get 12−1=11 lb. total effective. This, divided by 5.6, gives 1.96

for the coefficient, instead of 2.72. I have only guessed at 1 as the deduction; any reader can make his own estimate. some of the diagrams on the sheet show an actual open space between the high and the low, and I have no doubt that these are much nearer the truth than are those that lap. The state of the case is clearer shown adding to the cards lines joining the simultaneous points of high exhaust and low admission, and these cards are marked with arrows to show whether the steam is running up hill or running down.

I have added measuring lines to all the diagrams on the sheet. In running up the compression corner, I have, of course, experienced the usual difficulty of having no statement of the amount of clearance. I have added the lines to illustrate the system of measurement, and where the compression line is not definite it will be found that any possible error will not sensibly affect the results arrived at. From the last sentence in your editorial last week I understand you mean to point out that, after all, the coefficients worked out as Mr. Smith advocates are in practice really serviceable. It is to meet your remarks I have worked out the coefficient for the diagrams shown in this sheet. They compare as under:

	By Mr. Elder.		By Me.	
Terminal pressure.		Coefficient.	Coefficient.	Due-terminal
H	4.7	2.547	2.324	5.15
B	5.0	2.54	2.151	5.9
C	3.5	2.72	2.644	3.6
D	4.18	2.48	2.592	4.0
E	6.5	2.24	2.183	6.65
F	4.0	2.60	2.543	4.7
G	2.9	2.61	2.294	4.45
A	4.6	2.60	2.115	5.65
1	3.6	2.64	2.682	3 62
2	4.4	2.72	2.14	5.6
3	11.6	1.94	1.821	12.4
4	14.5	1.66	1.673	14.4

It is evident from an inspection of these that the numbers in the two columns headed "Coefficients" cannot be substituted for each other. Some of my numbers are nearly equal, as E, F, and No. 1, while many of mine are much less, as B, G, A, and No. 2. In fact, their relation to each other is quite accidental, and if the diagrams themselves were cleared of their anomalous features, overlapping, and want of head, many of my numbers would be much reduced.

One of your correspondents wrote that I was indulging in hair-splitting, signifying that the difference between the results of the two modes of calculating coefficients was really of insignificant amount. I think the difference between 3.32 and 2.64, or between 2.72 and 2.14 is rather more than a split hair, and I would suggest to him that if he illustrates by hairs at all, he should admit that there is enough in the difference to make a good-sized chignon. Mr. Smith's 3.32 is head and chignon, and the 2.64 is the genuine article.

As to priority, the point in dispute has to me no value beyond maintaining the veracity of my statements. Mr. Alexander Elder knows that what I wrote about his bringing me the diagrams is the truth; if I had thought he would have objected to my naming it, I would certainly have avoided doing so. The earliest date on the lithograph reproduced here, is that of diagrams taken on the west coast of South America on the 16th May, 1860. These could not have been in the possession of Messrs. Randolph and Elder on the 1st June, 1860, the date of the *Artizan*, containing the following statement. Having described a common hyperbolic curve to include the actual diagram, and drawn PCeO, the rectangle of pressure by volume at the beginning of the curve, I then give the following rule: "To ascertain the practical efficiency lessen PCeO by the product of the pressure volume of the steam in the cylinder when the port is opened for the admission of steam, and divide the area of the actual diagram by the remainder, the quotient is the practical efficiency."

So that even if it could be shown that the numbers given by Mr. Elder are really coefficients, it cannot be meant that this lithograph, said to be printed in 1861, is any evidence that he originated what I had published in June of the previous year. But, on the contrary, all the evidence is on the other side, that Messrs. Randolph and Elder have never at any time published coefficients of performance, for the 2.72 for instance, of diagram No. 2, is in no sense whatever a coefficient of the efficiency or economy of the engines of the steamer Bogota. It is, however, clearly proved by Mr. Smith and Mr. Olrick that to Messrs. Randolph and Elder is due the introduction of what is a most egregious blunder into steam engine calculations, whereby a gain from expansion, equal to 1.14 is published as 1.72, or as 50 per cent. more than it actually is. If having done so be esteemed an honour, I will not dispute their right to it.

I am, Sir, yours most respectfully,
J. McFarlane Gray.

12, Montenotte, Cork, 11th Dec., 1871.

To the Editor of Engineering.

Sir,—Whilst thanking you for the attention bestowed on my note in your appended editorial comment thereon in last issue, you must permit me to remind you the equation

$$\frac{r\,p_m}{p_1} = 10 - 9\,r^{-\frac{1}{3}}$$

is not a *law*, and, moreover, is only approximate "between one×twelve atmospheres"—page 302, art. 285—the result obtained by supposing r infinite is therefore inapplicable.

When r is infinite

$$\frac{R\,p_m}{p_1} = \frac{H}{P\ V};$$

and the efficiency of the fluid is equal to unity as perfect

$$= \frac{r\,p_m}{p_1}\,\frac{P\ V}{H} = 1.$$

The efficiency for any intermediate value of r, within the limits of the expression

$$10 - 9\,r^{-\frac{1}{3}}$$

will be the product

$$(10 - 9r^{-\frac{1}{3}}) \times \frac{P\ V}{H} = \text{efficiency}$$

the values of P, V, and H, corresponding to any initial pressure, p_1, may be found by means of Table VI., page 564.

As regards my application of equation (2) of art. 285,

$$\frac{H_1 - H_2}{H_1} = \frac{T_1 - T_2}{T_1 + 461.2}$$

T being degrees of temperature on Fahrenheit's scale, only (as defined and used throughout the third part of the "Manual" of Professor Rankine) it must be remembered this equation expresses the "law of the efficiency of elementary thermodynamic engines," through all ranges of temperature on the instance in my last, the range being from $T_1 = 228°$ Fahr. to $T_2 = 113°$ Fahr., and giving the efficiency $= 0.239$ as an unapproachable limit, was merely adduced to show the absurdity of quoting higher efficiencies for actual steam engines working within the same limits.

Your obedient Servant,
W. M. Parr.

[The coefficient 0.259 referred to by Mr. Parr, merely relates to the work performed during expansion, to which there has to be added a number representing the work done prior to expansion. Approximately this may be taken as 0.1, making the total coefficient 0.359. If our correspondent will refer to the first foot-note in the middle column of page 376 of our number for December 8th, he will see that we expressly directed attention to the fact that the expression $p \propto r^{-\frac{10}{9}}$ is not correct for extreme measures of expansion. —Ed. E.]

THE NINE HOURS' MOVEMENT.

To the Editor of Engineering.

Sir,—It appears to me very desirable that the London engineers should know the exact terms upon which the various engineering establishments in the North, and particularly in Newcastle, have conceded the nine hours' movement to the men. Can any of your correspondents or readers give this information? Do the wages remain as before, and how is overtime to be counted?

Yours, &c.,
December 12, 1871. An Old Subscriber.

[A reply to our correspondent's queries will be found in our "Notes from Cleveland," on page 403 of the present number.—Ed. E.]

EXPRESS LAUNCHES.

To the Editor of Engineering.

Sir,—I have lately read and marvelled at the accounts of the wonderful performances of Mr. Thorneycroft's steam launches, but until the Canopus was honoured with a leading article last week, I, and doubtless many others, looked on them as puffs so very extravagant as to deceive nobody.

It has hitherto been the general impression that to make a steamer 200 ft. long steam 16 knots, was rather a clever thing to do, but what would Mr. Thorneycroft not do if he had such dimensions to work upon? If, as some authorities say, a vessel may be driven at a speed proportional to the square root of her length, then something over 30 knots per hour might be expected from a vessel of the Thorneycroft launch type 200 ft. in length.

Is the public to understand that the trial of the Canopus was conducted in presence of one of your staff, and consequently that the report is authentic?

Yours obediently,
Hugh E. Walker.

Glasgow, December 20, 1871.

[Our correspondent, who has converted a vulgar expression into a *nom de plume*, should know from personal experience that this journal "puffs" nothing. We can answer for Mr. Thorneycroft, that he will be willing to afford our correspondent every opportunity for satisfying himself as to the correctness of the statements made by us last week in the article entitled "Express Launches." The results referred to, which were only a repetition of what have been repeatedly given by the Canopus, were obtained in our presence. Any future communication from our correspondent on the subject to this journal, must appear over his own name.—Ed. E.]

TIN-LINED LEAD PIPE.

To the Editor of Engineering.

Sir,—In your last week's issue your Paris correspondent, describing these pipes, mentions the difficulty that has been found in making a solder joint.

Two years ago I gave these pipes (as manufactured by a Liverpool firm) an extended trial for water services, but was ultimately obliged to give them up on account of the same difficulty.

I should be glad to know if any of your readers have discovered a method of jointing them, with certainty, without melting the tin, and with strength sufficient to stand a pressure of a head of water of say 200 ft.

I am, Sir, yours obediently,
W. H. G.

Birmingham, December 18, 1871.

MACHINE FOR FLANGING BOILER PLATES.

To the Editor of Engineering.

Sir,—In your journal of the 15th inst. I notice a further letter by E. Hanson, which has not seriously altered my views respecting the royalty having been paid to the late David Hanson. Possibly, by some means a receipt may have been given for 5s. instead of 50*l.*, which I paid. As regards the offer the late David Hanson made me, the entire facts are misstated; he not only offered that I might make his machine at my own works, but volunteered to find plans, and further none of my leading men ever waited upon or consulted D. Hanson on my account, except one man, as a messenger, to tell him to see me at my office.

In reference to a further letter by William Muir and Co., the facts set forth in my last letter, published in your journal of December 8, need not be reiterated; perhaps Wm. Muir and Co. will deny their own signature next. I may further state, when I first consulted Mr. Muir respecting my improved machine, he made little of Hanson's patent, but said a great deal to impress me that he was entitled to the credit of the design. No doubt can now exist of the same desire to claim the merit of my invention, notwithstanding the date of my patent and the agreement signed by William Muir and Co. and myself.

I am, Sir, yours truly,
Daniel Adamson.

To the Editor of Engineering.

Sir,—I noticed in your issue of last week a letter by E. Hanson, on the subject of flanging machines. I may just say that I have been interested in the late David Hanson's machines from the first, having made all the plans and models, and worked out all the details for the same up to the time David Hanson took out his patent. With respect to the visits to the late David Hanson by one of Mr. Adamson's leading men, this, I presume, alludes to me, as a friend of Mr. Hanson's. I called upon him to see Mr. Adamson, who might put down a machine; at other times I have called, but merely on business between myself and the late David Hanson, which, I am sorry to say, was not completed.

Yours respectfully,
Samuel Wild.

[We can insert no more letters on this subject.—Ed. E.]

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Glasgow Pig Iron Market.—Within the last few days a greater degree of firmness has shown itself in the Glasgow pig iron market, and prices have gone up considerably. Last Wednesday's quotations were 69s. 6d. to 69s. cash, and 69s. 11d. to 69s. 6d. one month. Friday's prices differed little from those of Wednesday, but on Monday 69s. 8d. cash, and 70s. 1½d. one month were reached, and yesterday, in a very strong market, business was done up to 70s. 3d. cash, and 70s. 10½d. one month, closing sellers 70s. 9d. one month, and 70s. 3d. cash, buyers 1½d. per ton less. Increased firmness has been displayed to-day, and prices have been up at 70s. 10½d. cash, and 71s. 4½d. one month, sellers at the close still asking these prices, buyers 1½d. per ton less. The firmness displayed yesterday and to-day is due in part to the feeling inspired by the large shipments of last week. A very confident tone prevails. Some makers are unwilling to quote prices far forward delivery, owing to the feeling that much higher prices will be obtained. Pig iron is very scarce, all the daily make is being used up as fast as it is turned out, and the stocks in the public stores are rapidly diminishing. From Messrs. Connal and Co.'s stores there were 700 tons withdrawn last week. The quotations for makers' iron are still keeping firm at the prices mentioned in last week's report. Last week's shipments were: foreign, 6076 tons; coastwise, 7053 tons; total, 14,009 tons; corresponding week last year, 8835 tons; increase, 5174 tons; total increase for the year, 186,693 tons. The report from America is that there is no Gartsherrie in the market, and what little there is of Colinese commands a high price; the bulk of the stock is Gleagarnock.

Sale of Gartcosh Malleable Iron Works.—These works after being long in the market, and several times exposed to public auction, have at last been sold. They were again exposed last week, and purchased by Mr. Alexander Jack, of Glasgow, formerly assistant manager at the Monkland Iron and Steel Works. The upset price was 6300*l.*, and the sum paid by Mr. Jack was 7010*l.*

The Edinburgh Tramway System and the North Bridge.—At yesterday's meeting of the Town Council of Edinburgh, the subject of the widening of the North Bridge was under consideration in connexion with the extension of the tramway system. By a very large majority it was resolved to proceed immediately with the widening of the bridge, so that two lines of tramway rails may be laid upon it. The improvement which is thus about to be effected is one that has been agitated for during many years. In connexion with the Edinburgh tramway system it may be mentioned that the second portion is about to be commenced. Councillor Gowans, whose energy and business-like ability as a contractor were so conspicuous in connexion with the first portion, has had the additional contract offered to him.

Edinburgh and Leith Engineers' Society.—At last week's meeting of this society, which was very numerously attended, an animated discussion took place on the subject of "Tramways," following the paper which was read by Mr. H. C. Bell, C.E., on the previous evening. Mr. Alan Brabner, C.E., read a most interesting and able paper on "Bell and Helmet Diving."

Engineership to the Edinburgh Water Trust.—Following up the decision come to a few weeks ago as regards Mr. Stewart, who was dismissed by the new trustees from his post as engineer, the committees of the new trust have made a joint recommendation that Mr. James Leslie, C.E., Edinburgh, be appointed to the vacant office, at a salary of 300*l.* per annum; and that an assistant engineer be appointed to carry out the practical details in connexion with the works, that officer to be nominated by Mr. Leslie, and appointed by the trust at a salary of 250*l.* per annum.

London Association of Foremen Engineers and Draughtsmen.—We are informed that Mr. James Howard, M.P., has consented to preside at the 19th Anniversary Festival of this Institution, to be held at the City Terminus Hotel, on Saturday, the 17th of February next.

AGENTS FOR "ENGINEERING"

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Advertisements cannot be received for insertion in the current week later than 5 P.M. on Thursday. The charge for advertisements is three shillings for the first four lines or under, and eight pence for each additional line.

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ENGINEERING is registered for transmission abroad.

THE "ENGINEERING" DIRECTORY is published this week on the thirteenth page of our advertisement sheet.

NOTICE TO AMERICAN SUBSCRIBERS.

In consequence of the great increase in our American connexion, we have found it necessary to establish a branch office in the United States. Communications may in future be addressed to MR. GEORGE EDWARD HARDING, C.E., *of* 176, *Broadway, New York, who is our accredited representative.*

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of* 1*l.* 14*s.* 8*d.* ($8.32, *gold*) *per annum, payable in advance.*

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ENGINEERING.

FRIDAY, DECEMBER 22, 1871.

STEAM ENGINE COEFFICIENTS.

IN concluding our article on "Steam Engine Coefficients," published in our last number but one, we stated that the method of calculating such coefficients adopted by the late Mr. John Elder, and recently advocated in our columns by Mr. Charles Smith, frequently gives in practice results which are far more nearly correct than might be anticipated when the system is regarded from a purely theoretical point of view; and we now propose to explain the reasons for this, and to speak of some of the main points to which attention must be paid in attempting to deduce accurate coefficients from indicator diagrams. In the first place, however, it may be desirable to recapitulate briefly the characteristics of the two methods of calculating coefficients which have recently been discussed in our columns by Mr. Charles Smith and Mr. J. McFarlane Gray.

Mr. Smith (following Mr. Elder's system) obtains his coefficient by dividing the mean effective pressure deduced from the indicator diagrams, by the final absolute pressure which would exist in the cylinder if the expansion was continued to the end of the stroke, instead of being interfered with by the opening of the exhaust. To enable this final pressure to be ascertained the expansion curve must be produced to the end of the diagram when necessary, and the final pressure can then be measured from a zero line drawn for the purpose at a proper distance below the atmospheric line. This method is, as we showed in our recent article, equivalent to dividing a number representing the work done, by another number representing—not the steam used, but that thrown away—and, as we pointed out, this system is theoretically a false one. Mr. Gray, on the other hand, uses the same dividend as Mr. Smith, but employs as his divisor a number intended to represent the amount of steam used in performing the work represented by the dividend. This is obviously a perfectly justifiable system of calculating coefficients, and so long as the number employed as a divisor does really represent the quantity of steam used, it is free from all possible objection. The whole matter, when regarded from a practical point of view thus narrows itself to the question, whether the divisor obtained in the manner advocated accurately represents what it is intended to represent or not? This question we shall proceed to consider.

In dealing with this subject there are two facts which should carefully be borne in mind, and these are: 1. That the weight of steam actually present in a cylinder may, and most frequently does, vary considerably during the stroke, even after the point of cut-off has been passed; and, 2nd. That the maximum quantity of steam present in the cylinder during the stroke may, and generally does, vary to a greater or less extent from that actually expended per stroke. For instance, if we suppose the expansion to take place in a cylinder of such construction that the steam neither imparts heat to, nor receives it from, external objects, then if, during this expansion, work be performed by the steam, a portion of the latter will be condensed, the latent heat set free by this condensation being the equivalent of the work done. The effect of this condensation is that the pressure of the steam falls during the expansion at a more rapid rate than would be the case if no work was performed (under which circumstances the condensation just alluded to would not take place), and there consequently exists in the cylinder at the end of the stroke a less weight of actual steam than was present when the expansion commenced. When such circumstances as those we have just supposed exist, the end of the stroke is obviously not the correct place to measure the steam used, unless in making the measurement we make due allowance for the condensation which has taken place during the performance of work.

The investigations of Professor Rankine have shown that when steam of ordinary pressures expands under the conditions above supposed, the pressure is proportional to the reciprocal of the tenth power of the ninth root of the ratio of expansion, or, in other words, the relation between pressure and volume is given by the expression, $p \propto r^{-\frac{10}{9}}$, in which p is the absolute pressure of the steam, and r the ratio of expansion. Professor Rankine's researches also show that when dry saturated steam expands *doing work* in a jacketted cylinder, the fall of pressure appears to follow the law: $p \propto r^{-1\frac{1}{9}}$, the fall of pressure being in this case less rapid, owing to a portion of the heat which is converted into work being supplied by the condensation of steam in the jacket. In this case also, therefore, the quantity of steam existing in the cylinder would be less at the end than at the commencement of the expansion, although the difference would not be so great as when the cylinder was unjacketted. In our former article we showed that in the case of steam expanding without imparting or receiving heat, the terminal pressure existing at the end of the expansion, when the steam had been doing work, would have to be multiplied by $r^{\frac{1}{9}}$ to obtain the pressure which would have existed if, during the expansion, no work had been performed; and, in the same way, if the expansion has been carried out in a jacketted cylinder the multiplier just mentioned will be $r^{\frac{1}{11}}$ instead of $r^{\frac{1}{9}}$. We thus see that when steam expands under either of the conditions above supposed, and in a cylinder in which no cushioning takes place, the final pressure will be too low a unit of measurement of the steam used in the proportion of r to $r^{\frac{10}{9}}$ or $r : r^{1\frac{1}{9}}$, as the case may be.

But when we come to consider the conditions under which steam is very generally used in practice, we shall find two circumstances which cause the final pressure existing in the cylinder at the end of the stroke to be greater than it would be under conditions previously supposed, the first of these being condensation and subsequent evaporation, and the second the existence of cushioning. These two matters we shall deal with in the order we have mentioned them. In an engine using dry saturated steam and having its cylinder thoroughly well steam jacketted, the condensation which takes place in the cylinder when the steam is admitted at the commencement of each stroke, is exceedingly small and may, in fact, be neglected altogether, the expansion following the law $p \propto r^{-1\frac{1}{9}}$, as already stated. But in an engine with an unjacketted cylinder the case is very different. In this instance the steam on entering the cylinder comes into contact with surfaces having a temperature much below its own, and a certain proportion of the steam is thus condensed in raising the temperature of those surfaces. So long as the inlet port is open the steam thus condensed is made up by an additional supply from the boiler; but after the cut-off has taken place the new portions of the cylinder surface exposed by the piston as it advances have to be heated by the condensation of part of the steam shut into the cylinder, and the consequence is that the pressure at first falls in a more rapid ratio than that due to the expansion alone. As the expansion proceeds, however, and the pressure falls, the temperature of the steam becomes lower than that of the internal surface of the cylinder*, and thus there commences the re-evaporation of the thin film of moisture which had been deposited on the surfaces during the earlier part of the stroke, and the quantity of steam present being thus augmented, the pressure becomes higher than that due to theory. The result of these operations on the expansion curve drawn by the indicator is to cause it at first to fall below and subsequently to rise above, the theoretical expansion curve, as will at once be seen by drawing the latter curve on an indicator diagram taken from an unjacketted cylinder.

Under such circumstances as these it is evident that to obtain anything like accurate information respecting the maximum quantity of steam present in the cylinder during each stroke it is necessary to measure the pressure as near the end of the stroke as possible; and in such cases as this and when the amount of cushioning is small, the divisor obtained according to Mr. Elder's plan is one which is far more nearly correct than it would be if the pressure of the steam varied according to the laws explained in our former article. We have said that this is the case if "the amount of cushioning is small," and we must now point out how the amount of this cushioning affects the result. This brings us also to the second fact which we stated should be borne in mind in considering the question under discussion, namely, that the quantity of steam used per stroke, and the maximum quantity of steam present in the cylinder during each stroke, are by no means necessarily identical.

The pressure existing in a steam engine cylinder at any given point during the expansion is that due to the presence not merely of the fresh steam admitted during that stroke, but also to that of the steam retained in the cylinder by the exhaust port closing before the prior exhaust stroke was completed. The retained steam thus tends to make the terminal pressure higher than it would be if the whole steam was entirely exhausted from the cylinder during each stroke, and thus tends to increase the divisor obtained according to Mr. Elder's plan. If now the exhaust port closes early in the return stroke and the amount of cushioning is thus rendered great, the proportion of the retained steam to the amount of fresh steam actually admitted per stroke will become important, and the final pressure in the cylinder will become far too high to be anything like a true measure of the steam used per stroke. In such instances Mr. Elder's divisor will, of course, give a coefficient lower than the true one.

It is our intention, on an early occasion, to illustrate some of the facts we have been stating, by examining in detail actual examples of indicator diagrams; but at present our space will not permit us to do this, and we shall therefore proceed to consider the system of obtaining the divisor recommended by Mr. Gray; this divisor, it must be remembered, being intended to represent the pressure to which the quantity of steam used per stroke would fall, if allowed to expand to fill the cylinder *without doing work*.

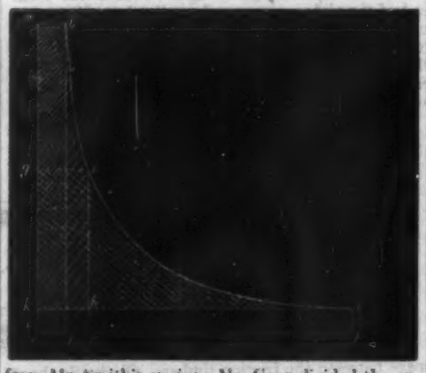
* We have, above, to avoid complication, spoken only of the *average* results. In reality the different portions of a cylinder acquire different temperatures, and thus re-evaporation may be going on from one portion of the surface while condensation is going on at another. At one part of the stroke these two opposite operations frequently practically neutralise each other, causing a part of the expansion curve to correspond to that which would be obtained if no heat was given off or received by the steam.

In his first letter on the subject, which appeared in our number of September the 22nd, Mr. Gray, in speaking of obtaining his divisor from indicator diagrams, says: "To get at this, we must measure the steam before any of it disappears from the diagram, and the best point to take it at is a little before the exhaust in the high-pressure cylinder. Generally, not always, there is a difference between the actual terminal in low and that due to the volume of steam shown on the high card. We should, therefore, in every case try what the high diagram will give us, and use it, if in excess of the low terminal. But in returning to the high cylinder we must avoid the compression corners, or the result will err on the other side. My rule for calculating the due terminal is this: Write down the ratio between the two cylinders—in this case 3.58. Multiply this by twice the length of the cards, say, in inches. Set off the product as a pressure above zero on the high-pressure diagram. Draw a horizontal line at that height. Measure on this line the lengths of both diagrams from expansion curve to compression curve; the sum of these two lengths in inches is the pressure in pounds due at end of stroke of low piston, if no steam disappears." This method of obtaining the due terminal pressure is an admirably convenient one for practical use, and is worthy of being carefully remembered; but in employing it, it is necessary to bear in mind that the divisor obtained by its aid should never be taken as the correct divisor without first ascertaining that it is at least equal to that obtained by measuring the steam at a later period of the stroke if the engine has but a single cylinder, or from the low-pressure diagram if the engine is of the compound class. In other words, as Mr. Gray has consistently maintained throughout his correspondence, the highest divisor should be taken wherever it is found. An important argument in favour of measuring the steam at a tolerably high pressure if possible, is that measurements so taken are less liable to be rendered untrustworthy by an abnormal state of the barometer at the time when the diagrams were taken. Of course, if the height of the barometer is noted at the time of taking the diagrams—as it always should be—it is immaterial at what pressure the measurements are made; but otherwise, as we have said, the argument in favour of high-pressure measurements is an important one. The measurements are, of course, taken from zero, and this zero is in its turn fixed by measurements from the atmospheric line. If the height of the barometer is not known, the depth of zero below the atmospheric line is generally taken as 14.7 lb.; but it may frequently happen that this is quite half a pound too high or too low, and the measurements from it are rendered erroneous accordingly, the proportionate effect of the error being much greater if the measurement is taken at a low pressure than at a high. For instance, let us suppose the zero line to be half a pound too high, then in a measurement of 5 lb. pressure this will induce an error of 10 per cent., whereas in a 25 lb. measurement, the error produced would be 2 per cent. only.

The deductions which we consider may be fairly made from the facts we have endeavoured to explain may be briefly stated as follows: 1. That Mr. Gray's system of obtaining the divisor for calculating the coefficient, if carried out in accordance with the spirit of his directions—namely, that the highest divisor should be taken wherever it may be found—is as correct practically as we formerly showed it to be theoretically; 2. That in engines having the cylinders so jacketted as to prevent condensation during the early part of the stroke followed by re-evaporation of the moisture so deposited, the divisor obtained by taking the final pressure on Mr. Elder's plan will be too low, and the coefficient obtained by using this divisor consequently too high; 3. That in engines working with a large amount of cushioning (and particularly non-condensing engines) the divisor obtained by taking the final pressure may be too high, and the coefficient calculated from it consequently too low; and, 4. That in a very large class of engines the condensation during the early, and the re-evaporation during the later portion of the stroke will cause the terminal pressure taken from the diagram to be the most accurate obtainable measure of the steam used, and that in all such cases Mr. Gray's coefficients, and those calculated according to Mr. Elder's plan, as advocated by Mr. Smith, will be identical. In other words, Mr. Gray's system of calculation being founded on sound principles, will give under all the conditions of practice results which are as accurate as can be obtained from indicator diagrams, without introducing rectifications of the latter, while coefficients calculated by using the indicated terminal pressure as the divisor will only possess that degree of accuracy when the conditions under which the steam is used are such as to render the indicated terminal pressure that used as the basis of his calculations by Mr. Gray.

It may be well to state here that, however calculated, coefficients obtained by the treatment of indicator diagrams in the manner we have explained, are, at the best, but approximative, the degree with which they approximate to the truth depending greatly upon the manner in which the steam is used. In all instances, however, the coefficients, even if calculated on Mr. Gray's system, will be somewhat higher than they should be, this being due, in some cases, to the fact that a portion of the steam is condensed in the cylinder, and not completely re-evaporated before the end of the stroke, and in others to the fact that a portion of the work done is performed by steam which is condensed in the steam jacket, and which does not appear in the indicator diagrams. The real position occupied by the coefficients calculated from the indicator diagrams, was very clearly pointed out by Mr. Gray in his letter published in our number of the 3rd ult. —so clearly, in fact, that we cannot do better than quote his words here. Speaking of the value of coefficients, he says: "The coefficients found are only first approximations, and are always only limiting coefficients, and err in excess. They tell us that not more than a certain effect was produced by the steam, they do not say that effect was really produced, but their testimony is absolute as a limit that not more than that effect was produced. They are to be taken as limits in this negative sense, and we approach nearer to the true positive coefficients as we legitimately reduce their amount by taking as a divisor the highest product of pressure by volume found throughout the whole stroke." These observations explain the true state of the case, and although it is possible, by carefully investigating the peculiarities of indicator diagrams, to introduce such corrections and rectifications as will render the coefficients obtained from them closely approximate to exactness, yet, with the amount of care which can usually be expended upon such matters in practice, coefficients, calculated from indicator diagrams, must be held to occupy a second place when compared with the measurements of efficiency obtained by the adoption of the system of testing engines perfected by Mr. B. W. Farey and Mr. B. Donkin, junior, already frequently referred to by us.*

Before concluding for the present our remarks on the discussion which has taken place in our pages, there is one other point connected with the measurement of coefficients respecting which we must say a few words. In dealing with the diagrams taken



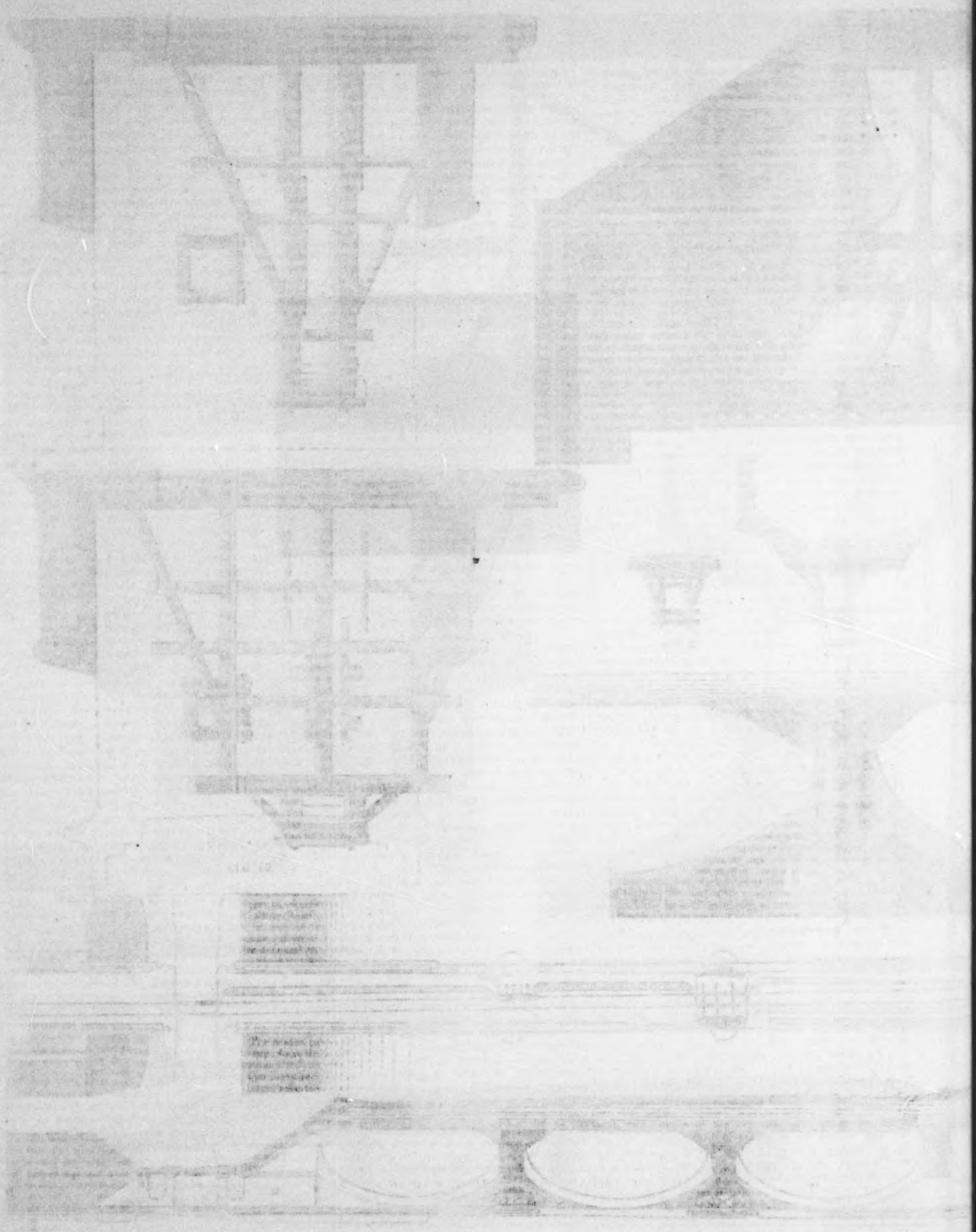
from Mr. Smith's engines, Mr. Gray divided the expansion into two stages, the first portion of the expansion being supposed (in accordance with the curve drawn by the indicator) to take place according to Mariotte's law, and the second according to the law $pv^{1.6}$. In calculating the portions of the total coefficient due to the different portions of the expansion, Mr. Gray of course used as the divisor, in accordance with his regular practice, the number representing the quantity of steam used; but Mr. Smith, in subsequently adopting this division of the expansion into two stages, did not employ the same divisor for both stages, but used Mr. Gray's for the first, and his own for the second stage. As it is not improbable that a similar plan may be adopted in other cases where the expansion is divided into two stages, and where Mr. Elder's method of calculation is used, we propose to show its error. In the annexed figure let *abeijc* be an indicator diagram, and let the rectangles *abde* and *kijc* represent respectively the quantities of steam admitted to and discharged from the cylinder per stroke, the former being greater than the latter by the amount of steam actually condensed in performing work. Then, as we explained in our former article, Mr. Gray's coefficient will be obtained by dividing the area *abijc* by that of the rectangle *abde*, while, according to Mr. Smith's or Mr. Elder's plan the area *kijc* will be employed as a divisor. Now, in the particular case referred to above, the coefficient was considered by Mr. Gray as made up of three parts, namely, first, that due to the work performed by the steam prior to expansion, represented by the area *abde*; second, that performed in expanding to the pressure *ef*, this portion being represented by the area *befd*; and, third, that due to the remainder of the expansion, and represented by the area *eijf*. Mr. Smith, on the other hand, measured this latter part of the expansion by using the area *kijc* as the unit of measurement, and thus obtained for the third portion of his coefficient a number representing the area *geik*, instead of that *eijf*. In other words, the total coefficient became a number represented by twice the rectangle *gehk*, added to the areas of the spaces *abeg*, *khfc*, and *eih*; the rectangle *gehk* being thus measured twice over, and that *kijf* omitted. If the curve *bei* was a common hyperbola, the rectangles *gehk* and *kijf* would be equal to each other, and the mixing up of the two units of measurement in the manner above explained would then of course introduce no error; but in proportion as the curve *bei* departs from an ordinary hyperbola, so does the effect of the mistakes we have pointed out increase.

In conclusion, it is only just to Mr. Smith that we should direct particular attention to a fact which, in the discussion respecting coefficients generally, is apt to be lost sight of, and that fact is, that whether calculated by Mr. Gray's system or Mr. Elder's, the coefficients of the engines built by Mr. Smith are very high. Adopting Mr. Smith's measurement of the mean effective pressure Mr. Gray makes the coefficient 2.64, while adopting his own measurements from the diagrams published he gets the result 2.55, a coefficient which will compare very favourably with those calculated in the same way from other engines.

* *Vide* page 279 of the present volume, and pages 320 and 334 of our seventh, and page 28 of our eighth volume.

THE INSTITUTION.

Pressure on our space this week compels us to publish only a short abstract of the annual report of the Institution of Civil Engineers, but we may, however, refer to certain salient points which characterise the document prepared by the Council, and which give to it more than usual interest. There are three subjects to which the Council specially allude as having been brought under their notice, and that of the Institution, during the past year; the effort made to introduce certain important modifications into the administrative system; the correspondence between the Council and the Secretary of State for India relative to the Indian Civil Engineering College at Cooper's Hill; and the measures decided upon to insure a more careful selection of candidates. The history of the proposed alterations above alluded to, commenced by the reception of an Address endorsed by 236 names in all, of members and associates. The document stated that, in the opinion of the subscribers, the number of members on the Council should be increased from seventeen to twenty, that three of the old bye-laws should be modified, and a new one passed. It was suggested that two of the new members of Council should be elected from the class of members, and one from that of associates, and that each year two of the Council of each class should become ineligible for re-election until the expiration of one year. Both these propositions were regarded as likely to be prejudicial to the administration of efficiency of the Institution; but on the occasion of the first special meeting, held to consider the subject, the proposition to increase the number of the Council was carried. The proposed new bye-law was, however, withdrawn. Shortly afterwards the Council assembled another general meeting, to consider the



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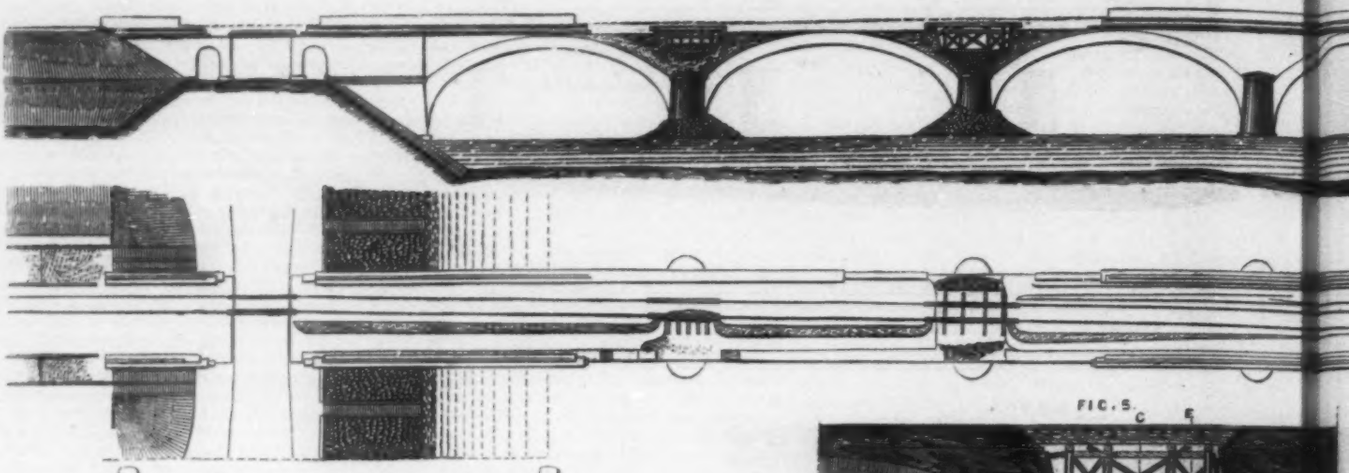


FIG. 5.

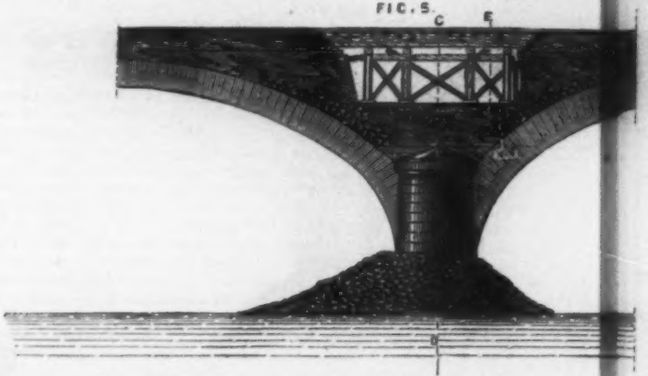


FIG. 10.

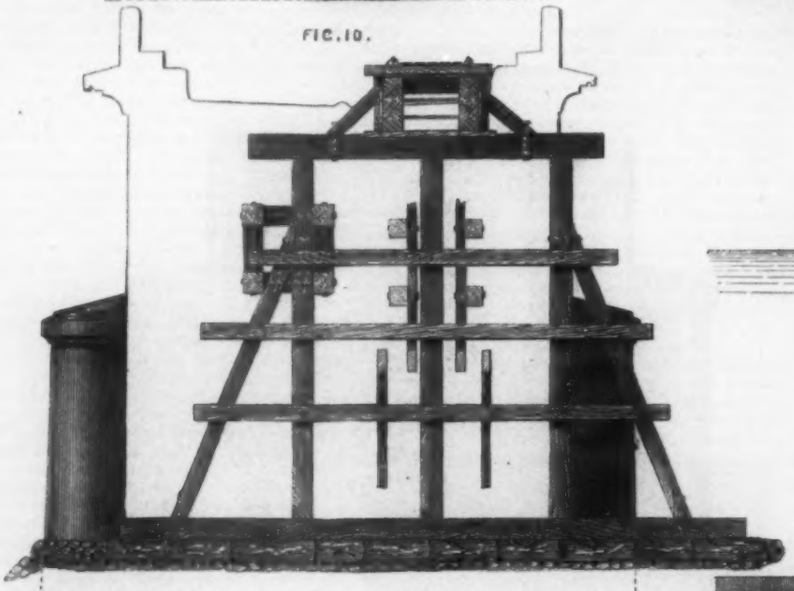


FIG. 7.

FIG. 6.

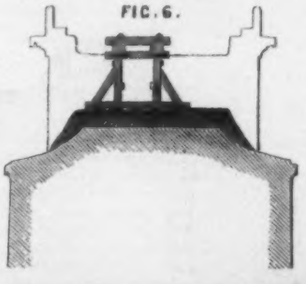
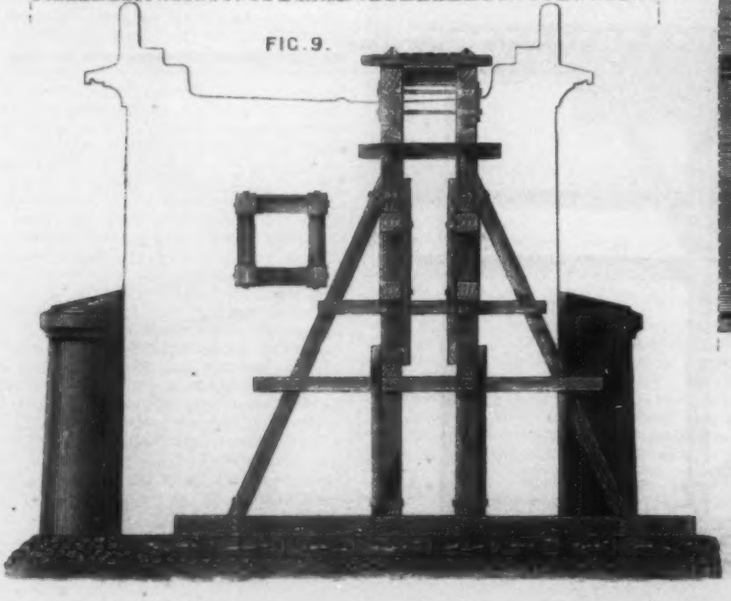
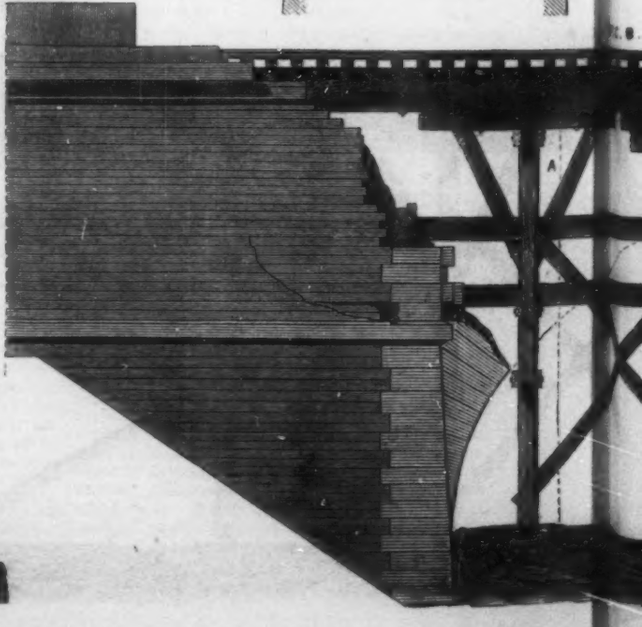


FIG. 9.





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ATEL, ENGINEERS.

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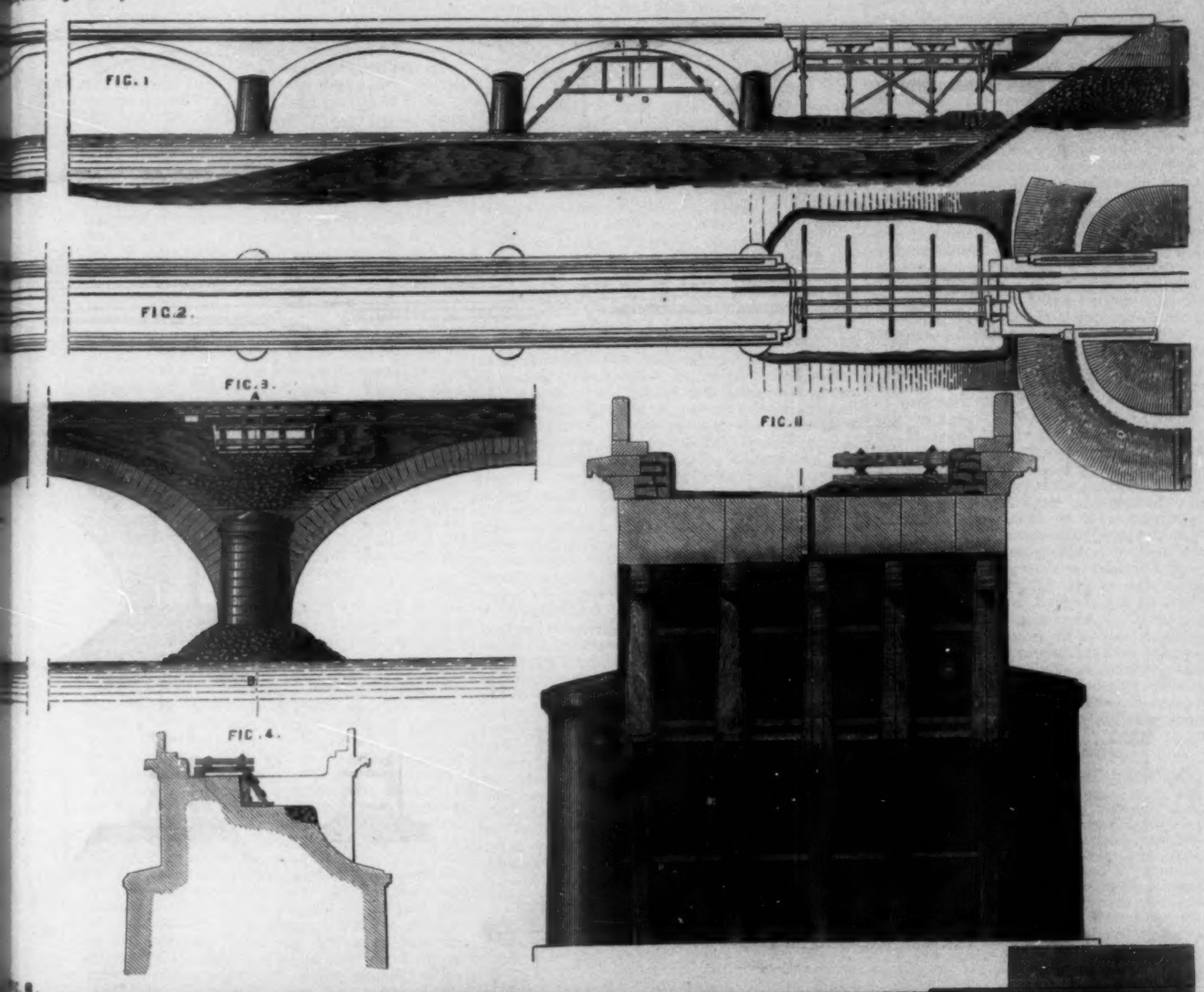
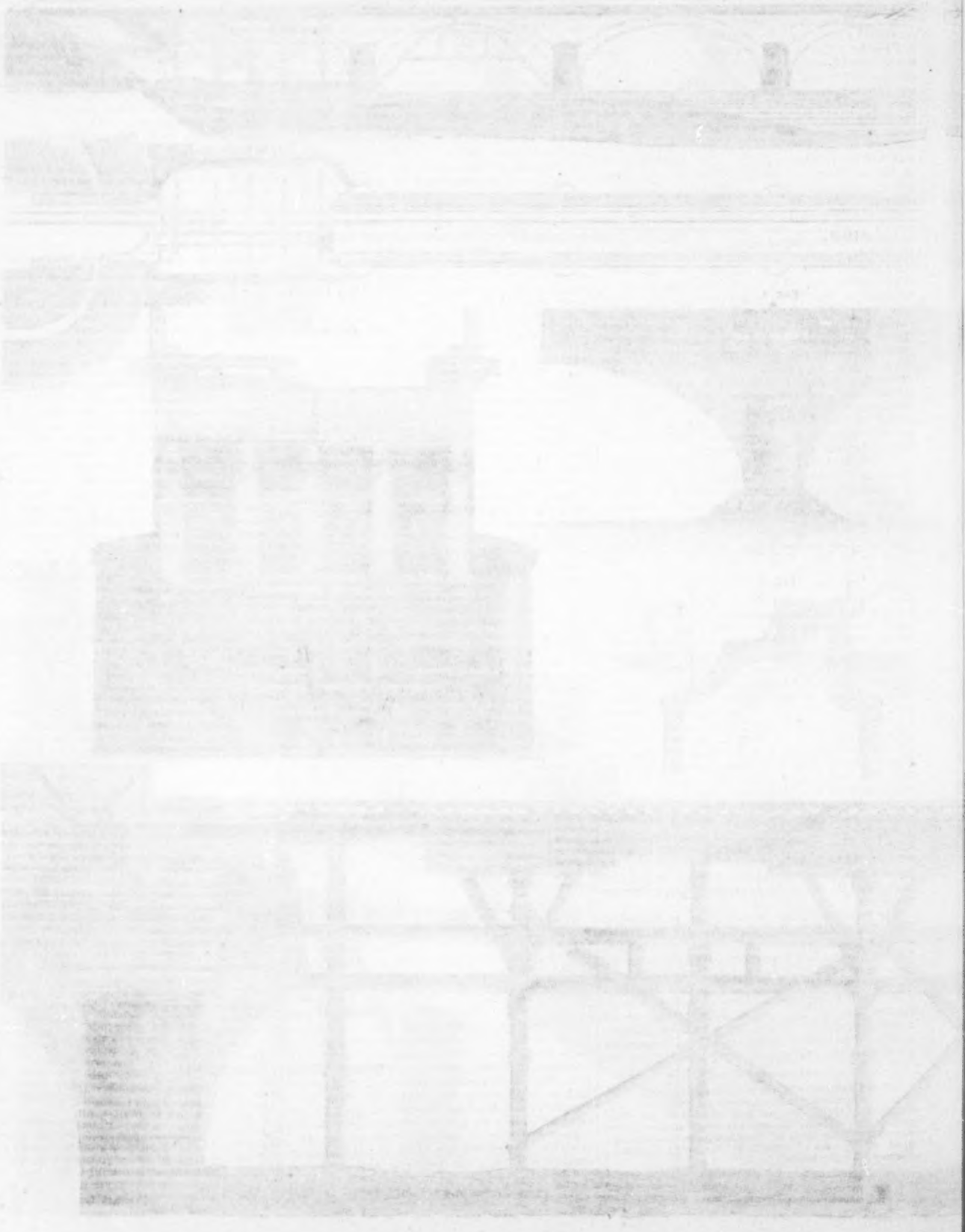




amendment of certain of the existing regulations, and especially with regard to alterations in the balloting list. The result of these deliberations was that in future the names of 23 instead of 17 members, and 6 instead of 4 associates are to be placed on the paper, and no distinctive type shall be employed in printing the names.

In March last Mr. Charles B. Vignoles submitted to the Secretary of State for India an extract from the Minutes of the Council, and expressed his readiness to afford any further explanation should it be desired. In this Minute the President and Council submitted that in their opinion the establishment of the Cooper's Hill College was unnecessary, and its prospects unfavourable. They considered it due to the Institution and the profession at large to point out that the existing means of training engineers were efficient and ample, and if past experience of the young men obtained for the Indian service has been unfortunate, the fault lies with the means adopted to secure engineers, and not with the status of the profession itself. They point out that so far as theory is concerned there exist a number of institutions fully competent to impart instruction, whilst the means proposed for giving practical education to the pupils of the college are utterly insufficient, and that their real practical training will commence out in India, in a more marked degree than has been the case with assistants already drafted from the offices of engineers, and to whom a certain amount of sound practical information has been imparted. Finally, they point out, with perfect justice, that the insufficient pay and the unfair treatment which characterises the lot of the civil engineer in India must always prevent the supply of competent men fulfilling the demand. To this Minute the Duke of Argyll returned, after some months' delay, a brief and significant reply, expressing his regret that the establishment of the college did not meet with the approval of the Institution, and stating that the perfect clearness of the Minute prevented any further explanation being necessary.

To the third feature in the annual report—that referring to the exercise of caution in the election of candidates—we have already referred on a former occasion. The Council has to use great discretion in this matter, to check undue exclusiveness on the one hand, and to prevent the introduction of too general a class on the other. We do not think that more can be done than is done, and the revised forms which have been prepared meet all requirements. The business of the Institution during the year has been conducted in its usual excellent manner, and the last volumes of the *Transactions*—which we hope shortly to review—are remarkable for the care and labour which have been bestowed upon them. The effective strength of the Institution on the 30th of November last was 1786, as against 1703 on the corresponding date of last year. Of these 14 are honorary members, 724 are members, and 1048 are associates. The new elections have numbered 128, and the deaths 45, so that the effective increase is 83, a smaller number, with one notable exception, than any during the past five years. Of the student class an increase of 17 per cent. has been registered, which speaks well for this branch of the Institution, better than do the number of papers prepared by them at the supplementary meetings, only seven having been read during the session. On the other hand, the regular business of the Institution during the year has been very satisfactory, as is attested by the fact that the proceedings occupy two bulky volumes filling 895 pages, and 23 sheets of engravings, and numerous woodcuts.

The receipts during the last year amounted to 7635*l.*, of which 5593*l.* were obtained from subscriptions, and the general disbursements were 5494*l.* On the 30th of last November the funds of the Institution were 25,373*l.* as compared with 23,145*l.* on the same date last year.

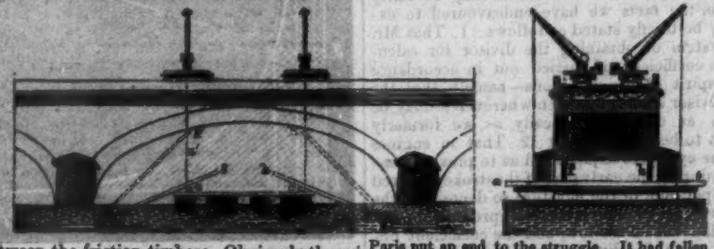
Altogether the report of the Council is a satisfactory one, and bears within it indications of the renewed prosperity which has set in for the profession, a prosperity which will help to make the present session even a more fertile one than the last.

SOUTH KENSINGTON MUSEUM.—A beautiful silver cup, the work of Jamnitzer, the Nuremberg goldsmith, and contemporary of Cellini, has just been added to the art collection. The educational division has lately received a very curious toy house made in Nuremberg two centuries ago, filled with models of utensils of the period illustrating German life and manners.

NAVAL ORDNANCE.

THE question has frequently been asked, when was wrought iron ordnance first introduced on board ships of war? When was breeching first dispensed with, and wrought-iron carriages introduced? The heading of our illustration on page 403, gives an answer to these queries. It also gives the name of the first screw steamship of war put afloat, and reminds us of the fact that the engines and propeller of this ship, as well as her armament, all emanated from the same constructor.

Captain Robert F. Stockton, of the United States Navy, on visiting England, 1839, for the purpose of witnessing the trial of a small screw steamer (the first iron vessel to cross the Atlantic), built for him by Messrs. Laird, to Ericsson's design, consulted the latter regarding the possibility of constructing naval ordnance of wrought iron. Ericsson being an advocate of that material, readily met the wishes of Captain Stockton, and at once prepared drawings of a gun of 12 in. calibre. The Mersey Iron Works being willing to enter into a contract with Captain Stockton, received forthwith an order from that enterprising and spirited officer to build the gun at his expense. The United States Government subsequently ordered the construction of a steamship of war, under the supervision of Captain Stockton, with steam machinery and propeller to the drawings furnished by Ericsson. Experienced commodores at the time protested loudly against the proposition to mount "the monster gun" on board a vessel so lightly built as the Princeton, insisting that among other difficulties, the breeching would tear her upper works to pieces. It was urged by the opponents of the new system that the handling of such guns at sea would prove impossible, the constructing carriages of sufficient strength being pointed out as impracticable; while the imprudence on the part of the navy department to intrust such matters to mere engineering skill was severely criticised. In spite of all remonstrance, however, Captain Stockton's influence with the Government prevailed, and the construction of the ship, her engines, and propeller, was vigorously pushed. In the meantime the problem of handling the 12 in. gun received due attention. Calculations of the dynamic equivalent of the recoil convinced the constructor that a moderate resistance, if continuous and uniform, would suffice to bring the piece to rest in less space than that required by breeching. Friction, being the simplest means of obtaining a continuous resistance, was accordingly resorted to. The method adopted will be readily comprehended by reference to the illustration on page 403, which represents a side elevation, top view, and end views of the gun, carriage, and slide, mounted on board the Princeton, in 1843. Two pieces of timber of semicircular section, placed a few inches apart, slightly taper towards the front end of the slide, are secured to the latter in such a manner as to admit of some vertical motion. A broad hoop of plate iron, attached to the carriage, clasps the two timbers. An axle provided with a cam in the middle, operated by a lever, is placed across the front end of the slide passing through the



space between the friction timbers. Obviously these timbers will be pushed apart with considerable force if the transverse axle be turned so as to place the cam in a vertical position. The friction between the hoop and the timbers produced by the pressure of the cam, it is scarcely necessary to observe, will be greatly enhanced during the recoil of the gun, in consequence of the increasing vertical depth of the timbers towards the rear end of the slide. The transverse axle being turned so as to place the cam in a horizontal position, permitting the friction timbers to approach each other, will, of course, at once relieve the friction. The monitor gun carriages, constructed like the Princeton's carriage, differed as regards the mode of clasping the friction timbers, a *screw* being employed to produce the requisite compression in place of the transverse axle and its cam. The slow fire of the monitors, complained of during the late war, it is well known, was owing to the time lost in screwing up and relieving the compressors. Accordingly we find that Ericsson has returned to his original mode of tightening the compressor. The carriages of the thirty Spanish gunboats and all his recent carriages, are provided with the transverse axle and cam; consequently the setting up and relieving the compression is almost instantaneous, as it was in the original carriages.

The 12 in. wrought-iron gun of the Princeton, as we have stated, was manufactured at the Mersey Iron Works of the very best materials it has been asserted; but on being tested in America, it proved too weak. The designer, therefore, resorted to the expedient of hooping the breech of the piece up to the trunnion band; the hoops being made of the best quality of American wrought iron put on in two tiers, shrunk one over the other in such a manner as to break joint. This expedient proved entirely successful, the gun having stood all tests to which it has been subjected. It was a solid cast-iron shot from this 12 in. gun which in 1842 pierced a wrought-iron target 4½ in. thick, up to that period considered proof against naval ordnance.

The authorities at Washington, some time before the war, ordered the Princeton gun to be fired until destroyed, but after about 150 rounds the firing, it appears, was discontinued.

The Americans having been the first to introduce heavy wrought-iron ordnance for naval purposes, why do they not build the guns for their monitors of that material? European artillerists are continually putting this question. Probably the answer will be found in the fact that, although having in the mean time successfully constructed rifled wrought-iron ordnance of considerable size, their first essay at building heavy guns for naval purposes proved most disastrous. Immediately after the trial of the gun which we have described, a 12-in. smooth bore, of much heavier metal, was manufactured at Hamersley Forge, in New York, considered at the time to be a remarkable specimen of good workmanship. It was at once mounted on board the Princeton, by the side of its slender companion, upon a similar carriage. Much confidence was placed in the strength of this magnificent gun on account of the supposed superior quality of American iron. It stood the proof-charge and some preliminary tests, but on being fired on a festive occasion while the ship was at Washington, the admired piece burst, with the sad result remembered by many of our readers.

RECONSTRUCTING BRIDGES.

THE German invasion of France, as is well known, brought with it great destruction of property, and especially of railways. The Orléans Railway Company's system was successively occupied by the Prussians in the Departments of the Seine, the Seine-et-Oise, of the Loiret, Eure-et-Loir, of Loir-et-Cher, of the Sarthe, and of Indre-et-Loire. It was in these departments, and especially in the plains of Beauce that the most vigorous efforts were made during the siege of Paris to resist the flood of invasion which sometimes advanced, sometimes receded, until the capitulation of Paris put an end to the struggle. It had fallen especially to the lot of the Orléans Railway Company, during more than five months, to follow the movements of the French armies, to act in concert with them, and to establish the most rapid and complete communications. The most important services required were of course to convey supplies and munition, and to bring up reinforcements. These reinforcements consisted at times of such considerable masses, that they absorbed all the available means of transport. Thus, on the eve of the battle of Coulmiers, an army of 70,000 men was conveyed in a few days from Salbris, in Sologne, to the forest of Marchenoir, in Beauce, by using the lines from Vierzon to Tours, from Tours to Beaugency, and from Tours to Vendôme.

The maintenance of communication was, besides, of vital importance to the population, reduced by requisitions and deprived of all news during the German occupation. When the company took re-possession of the lines they found themselves confronted by the most disastrous

damages of all kinds. If the permanent way was simply overthrown, its restoration was easy. If the broken bridges had only about 30 ft. span, there were still simple means for rapidly restoring the road, either by throwing timber or iron girders over the openings, or by filling them up with earthwork.

When, however, the broken bridges had an opening greater than 30 ft., it became necessary to execute more important works, of which the engravings we give this week form an illustration. It applies exclusively to bridges or viaducts in stone, for the repairs of which three systems were adopted:

1. Girders in timber.
2. Girders in iron, cast or wrought.
3. Earthwork.

We will describe particularly the proceedings employed in their temporary state, which are the most interesting, and we will recal the circumstances under which they were executed.

The permanent works of reconstructing arches were undertaken soon after the temporary repairs, and to-day are almost completed. With regard to them it is sufficient to say generally that the arches were rebuilt upon temporary staging without interrupting the traffic, and according to one of two methods:

1. A certain number of arches were executed, for the whole span and full thickness, leaving only the spaces necessary for the passage of wooden supporting girders. After the completion and decentering of the arches, the timber girders were removed piecemeal, and the spaces they occupied were filled up with masonry.

2. Other arches were constructed without spaces, strong iron bracing being employed.

The bridge of Montlouis, which we illustrate, offers an example of reconstruction with timber staging. This bridge carries the line from Orléans to Tours over the Loire, between the station of Vouvray and Montlouis. It consists of 12 arches of 81 ft. 2 in. span. Figs. 1 and 2 show enough of the structure, to indicate the damage it sustained during the war. The French blew up the filling over the second and third piers between the arches on the left bank on the 13th December, 1870, and the Germans destroyed the first arch, and the abutment on the right side on the 28th January, 1871.

The temporary repairs over the piers by means of timber staging, and the re-establishment of girders in cast iron on the Montlouis side, were made four different times by the Orléans Company, the three first times during the war, and the last time directly after the signing of the armistice. These works, shown in Figs. 3 to 7, were rapidly completed on account of their small importance. Figs. 8 to 11 show the more important works which had to be executed for the repairs of the first arch and the abutment. They consist of a timber staging, intended to carry the permanent way, and in the precaution taken to prevent movement in the second arch. Care was taken to unload this second arch of the ballast and the permanent way, but on account of an accident which took place on the Saint Côme bridge, on the line from Tours to Mans, it was determined to brace it thoroughly. This was done in a twofold manner, first, by horizontal timbers which were used to tie the pier to the abutment, and to prevent any oversetting; second, by a centering. The putting up of this centering presented some difficulties, on account of a flood of some 9 ft., which happened at that time in the Loire. The current was very rapid near the second pier, and as it was feared that it would drag the struts when they were being placed in position, precautions were taken to stiffen the foot of each piece of timber by means of rails framed into the pier. The centres were put together in the station of Montlouis, and floated to the site. Under the second arch two barges were anchored, and upon them a timber platform was placed. The work of lifting the timber was done by means of four rolling cranes, placed on the two lines of way, and the chains of which descended to the boats. The sketch on the preceding page shows the method adopted. Two large timbers, $a\,b$ $c\,d$, were placed on the barges across the arch, and the chains of the cranes took hold of the extremities of each of them. The raking struts were first placed in the position indicated by the letters $e\,f\,g\,h$. Then keeping the work in hand by four cranes at a time, the cross-pieces, as well as the raking struts, were raised, as shown in the dotted lines $e\,f'\,g\,h'$ and $a'\,c'$. The struts were then connected by horizontal ties at $a\,b\,c\,d$. The five frames of the centre were then set in place in five days, despite the flood in the Loire, which would have rendered any other course long and difficult. The placing of the timber staging was effected on the first arch, at the same time as the centering in the third. Figs. 8, 9, and 10 explain the plan of staging fully. It is composed of trestles strongly braced together, and carrying the roadway. It was necessary to give these trestles an immovable foundation, and it was impossible to think of using piles, because the arch in falling had covered with fragments the whole space between the arch and the abutment, but as it had been broken into large pieces, the most suitable were utilised as footings for the trestles. Thus the position of these blocks determined that of the trestles. The pieces chosen were arranged at 6 ft. below low-water mark, and they were consolidated with plenty of broken stone.

The trestles, A, A', and A'', were the only ones at first put in place, and, indeed, they were the only ones that were wanted, but the German engineers, who were then in control of the works of the company, insisted, in addition to the trestles, B and B', which were not kept up during the reconstruction of the arch. The fitting of the trestles was done by means of shears, and present nothing worthy of mention, except that the electric light was employed during the nights that the continuous labour was carried on. The works were commenced on the 3rd of February, and on the 20th the first engine passed over the bridge. This temporary work was immediately subjected to a very heavy traffic. The Prussians brought over it immense quantities of material from Germany, and it was by this line they afterwards carried back their troops. Severe tests were first made by drawing over engines brought from Brittany during the war, and the passage of 11 locomotives at a time, produced no motion either in the masonry or the woodwork.

The whole of these works were of course executed under circumstances which gave no chance of economy. There were at first many difficulties of supply, because the roads had been cut on all sides. It was difficult, too, to find the necessary workmen for the work, because the war had absorbed them. Lastly, the works had to be completed with all despatch, in order that the traffic might suffer as little as possible, and everything had to be sacrificed to rapidity of execution. The actual cost is, however, of great interest, for if it does not serve as a guide for work, conducted under ordinary circumstances, it will be useful to give an idea of the expenses of works under such different circumstances.

The following are particulars of some of the quantities of materials employed:

Centering under second arch. (*Figs.* 1 *and* 11):

Cubic feet of timber in the five centres	= 1148 cub ft.
Bridge rails used as counter weights	= 52.8 lb.
Weight of bolts, plate, &c. ...	= 30.8 „

Trestle Work. (*Figs.* 8 *and* 9):

	cub. ft.
Large trestles, B_1 B'' ...	7214
Small „	935
Longitudinal under rails	989
Longitudinal under rails between trestles	6474
Pieces for steadying stone work	70
	8363

Iron work in ditto:

	lb.
Weight of bolts ... ... =	1826
„ bridge rails ... ... =	814
„ mooring rails ... ... =	495
	3135

The temporary repairs for the first and the strengthening of the second arch cost as follows:

	£
Earthwork and stone filling...	169
Cost of timber	585
Transport of timber	75
Framing of timber	95
Raising of framing	110
Bolts anchors, and general ironwork ...	73
Auxiliary works	248
	1365
Deduct	
1st. The value of the two trestles, B_1 B', added by the Germans ... 97	343
2nd. Material sold 246	
	1022

Or per yard run, 37.7*l*.

The cost per yard run of the timber staging only, not including the consolidation of the second arch, was 31.42*l*.

We shall on another occasion illustrate and describe further works of temporary repairs to damage inflicted during the French and German war, deriving them from the same source, our contemporary the *Annales Industrielles*.

THE INSTITUTION OF CIVIL ENGINEERS.

The fifty-fourth Annual General Meeting, Mr. Charles B. Vignoles, President, in the Chair, was held on Tuesday, December 19, "to receive and deliberate upon the report of the Council on the state of the Institution, and to elect the officers for the ensuing year."

The report commenced by stating that, in the past Session, an address had been presented by a numerous body of the members and associates, recommending that the number of the Council should be increased from seventeen to twenty—the maximum permitted by the Charter—that two of such additional Councillors should be from the class of members, and one from the class of associates, and that each and every year two of the members and two of the associates of Council should become ineligible for re-election until after the expiration of one year. The result of the deliberations of the Council on this proposal was in effect, that the suggested increase in the number of their body was neither necessary nor desirable for efficient administration, and that the compulsory retirement every year of the two senior members, for that must have been the ultimate result of the measure as proposed, would, in their opinion, be prejudicial and disadvantageous to the interests of the Institution. A requisition having been made for a Special Meeting of members only to consider the question, such meeting was accordingly convened. A full report of the proceedings at that meeting, which was continued by adjournment, as well as at another meeting, had already been issued to every member and associate. Only the more salient points discussed at those meetings were therefore alluded to in the report, and a summary was given of the modifications finally adopted.

A subsidiary question remained, however, to be disposed of—that was the propriety, or otherwise, of recording on the balloting lists the number of the attendances of the members of Council in Council and at the ordinary meetings. Such a record had been kept for many years; it was only, however, at the Annual Meeting in 1866 that these attendances were ordered to be printed. Having been so ordered, it was not in the power of the Council to make any alteration in the practice. But as it seemed desirable that the custom should not be continued, and as its continuance would be the means of individualising the old from the new names on the balloting lists—which it had been in part the object of the changes lately made in the bye-laws to avoid—the Council recommended that the attendances should not in future be printed.

As a means of judging how far the Institution had facilitated the acquirement of professional knowledge, and aided in promoting mechanical philosophy during the past year, the ordinary meetings were next referred to. Of these there had been twenty-five, when eighteen papers were read, on very diverse subjects, which were recapitulated. These communications and the discussions upon them had been embodied in two octavo volumes (already issued to all the members), which it was believed must be regarded with unqualified satisfaction. To the authors of several of the memoirs, the Council had had the peculiar gratification in awarding, out of the special trust funds, bequeathed or assigned for the purpose, Telford medals and premiums to Messrs. B. Samuelson, M.P., A. Beazeley, T. D. Ridley, and J. Price; a Watt medal and a Telford premium to M. Gaudard; Telford premiums to Sir F. C. Knowles, Bart., and Messrs. W. R. Browne, H. E. Towle, G. B. Rennie, and A. Jacob; and the Manby premium to Mr. W. Airy, B.A. There had likewise been six supplemental meetings for the reading and discussion of papers by students, and for the essays so contributed Miller prizes had been bestowed upon Messrs. F. H. Mort, G. G. M. Hardingham, A. T. Atchison, B.A., H. F. Joel, W. Tweedie, F. Wilton, H. O. Smith, and R. W. Hedges. It was stated that the accessions to the Library had been more numerous than usual, and that the additions included many valuable official reports on public works in India and in the colonies. On the occasion of the President's Conversaziones, several changes were made which had been regarded as decisive improvements. Thus, instead of a miscellaneous collection of works of art, only such paintings and water-colour drawings were received as represented some engineering work, or matter of interest. Again, in regard to the models, small machines, contrivances, and instruments exhibited in the meeting-room, two or three special subjects were illustrated in a more or less complete series, besides miscellaneous objects. The members generally were urged to continue to make the Institution the depository of accurate information on the existing condition of knowledge and practice in different branches of engineering, in all countries, and with regard to machinery and manufactures connected with the profession.

Owing to the increasing number of applications for admission into the Institution, and for transfer from the class of associate to that of member, the Council had had under consideration the rules and regulations respecting the qualifications of candidates. These seemed to be amply sufficient, if strictly adhered to, to insure the election only of those whose avocations and antecedents were such as to render them worthy of the privilege. It had, however, been pointed out, that in every case the statement of qualifications must embrace a full and consecutive narrative of the career of the candidate, and that the proposer and seconders must have a *personal knowledge* of the details of the qualifications upon which the application was based. During the past session 11 associates had been transferred to the class of members. The elections had comprised 26 members and 102 associates, together 128, while the deductions due to deaths, resignations, and erasures amounted to 45, leaving an effective increase of 83 being at the rate of 5 per cent. in the twelve months. There had been 50 admissions to the class of students attached to the Institution, and 20 had been removed from the list from various causes, so that the net increase was 30, or 17 per cent. There were on the books on the 30th of November last 14 honorary members, 724 members, 1048 associates, and 203 students, together 1989, as against 945 ten years ago.

The deceases announced during the year included two honorary members, F.M. Sir John Burgoyne, Bart., and Sir John Herschel, Bart., both of whom had been borne on the register for 33 years; 11 members (these deaths being at the rate of 15 per thousand) who had belonged to the Institution for periods varying from 49 to 4 years, as recorded against each name—the average of the whole being nearly 28 years, viz., Yman D. C. Suermondt (49), Josiah Parkes (48), Philip Hardwick, R.A. (47), Thomas Wicksteed (34), Robert Benson Dockray (28), James Newlands (23), Albinus Martin (22), Samuel Power (21), John George Blackburne (16), Joseph Hamilton Beattie (14), and Herbert Louis Augustus Davis (4). Also 22 associates (these deaths being at the rate of 20 per thousand), viz., Lieutenant-General Sir William Denison (34), Colonel J. R. Western (29), Edward Mossely Perkins (28), Charles Dadian (27), Robert Ritchie (26), Octavius Henry Smith (16), Charles Frodsham (35), Joseph Freeman (21), Thomas Brassey (19), Edward Price (15), Captain George Baillie (10), Alfred Stansfield Rake (8), Samuel Tate Freeman (5), Thomas William Gardner (5), Henry George Hulbert (4), Henry Bendon Betten (4), Samuel Thomas Cooper (4), Henry Yarker Richardson (3), John Hastings Babington (2), Arthur Field (2), Clement Wilks (2), and Henry de la Poire Murphy (2). The average number of years that the associates had been on the books was thus less than 14.

An analysis of the abstract of receipts and expenditure for the year ending 30th of November last, when compared with the similar statement for the preceding twelve months, showed slightly diminished receipts, due to a smaller number

of elections; while the disbursements had been considerably less, although the liabilities were all promptly paid as they were incurred. On the credit side of the account 6022*l.* 9s. had been received from annual subscriptions, interest on investments not in trust, and miscellaneous sources, 1201*l.* 4s., from fees on admission and life compositions, and 411*l.* 16s. 4d. from dividends on trust funds, together 7635*l.* 9s. 4d. The disbursements had included on the general account 5019*l.* 8s. 11d., in respect of the new building a further sum of 214*l.* 13s. 10d. (making the total outlay already incurred 18,401*l.* 13s. 2d.), and for premiums under trusts, 261*l.* 1s. 8d., together 5494*l.* 19s. 5d. A sum of 2179*l.* 10s. 6d. had been invested in the purchase of 1500*l.* London, Brighton, and South Coast Railway 4½ per cent. debenture stock on the general account, and of 275*l.* 17s. and 442*l.* 6s. Three per cent. annuities representing the balances of unexpended income during the last five years, arising from the Telford and the Miller trust funds respectively. The nominal or par value of the funds belonging to the corporation was 12,156*l.* 1s. 8d., and of the trust funds under the charge of the Institution, 12,837*l.* 18s. 8d., and the cash balances amounted to 379*l.* 3s., together, 25,373*l.* 3s. 4d. as against 23,145*l.* 14s. 9d. at the date of the last report. This was irrespective of the value of the lease of the premises, of the books in the library, of the portraits, of the stock of minutes of proceedings, or of other property and effects.

It was mentioned, in regard to the Indian Civil Engineering College at Cooper's Hill, that the Council had submitted to the Secretary of State for India their reasons for thinking that such a mode of recruiting the engineering establishment of the Public Works Department was neither necessary nor politic. A copy of their minute, with the correspondence on the subject, was given at the end of the report. In reply to this communication, the Duke of Argyll had expressed regret that the course he had felt it his duty to take in the matter had not met with the approval of the Council of the Institution of Civil Engineers.

After the reading and adoption of the report, the premiums were presented by the President. It was then resolved not in future to print on the balloting lists the numbers of the attendances of the members of Council. The cordial thanks of the meeting were unanimously tendered to the President for his unremitting efforts to promote on all occasions the interests of the Institution and of its members. The thanks of the meeting were likewise given to the Vice-Presidents and other Members of Council for their co-operation with the President and their constant attendance at the meetings; to Mr. Charles Manby, Honorary Secretary, and to Mr. James Forrest, Secretary, for the manner in which they had performed the duties of their offices; and to the Auditors of Accounts for their services.

The Scrutineers of the Ballot (to whom a vote of thanks was accorded by acclamation) announced that the following gentlemen had been elected to fill the several offices in the Council for the ensuing year: Thomas Hawksley, President; Joseph Cubitt, Thomas Elliot Harrison, George Willoughby Hemans, and George Robert Stephenson, Vice-Presidents; James Abernethy, Sir William George Armstrong, C.B., William Henry Barlow, John Frederic Bateman, Joseph William Bazalgette, C.B., Nathanial Beardmore, Frederick Joseph Bramwell, George Barclay Bruce, James Brunlees, Charles William Siemens, Sir Joseph Whitworth, Bart., and Edward Woods, members; and Isaac Lowthian Bell, Henry Bessemer, and William Cawkwell, associates.

NOTES FROM THE SOUTH-WEST.

Welsh Railway Servants.—The fitters, smiths, carpenters, and masons of the South Wales Mineral Railway Company are agitating for a reduction of a week's work to 54 hours, viz., 9½ hours on the first five days of each week, and 6½ hours on Saturdays. They also ask that overtime may be paid for at the rate of time and a half, with the exception of Sundays, when they require to be paid at the rate of double time. A large meeting of the men employed by the Taff Vale Railway Company was held at Pontypridd on Sunday with a somewhat similar object. The Taff Vale men, however, do not ask more than that ten hours per day or 60 hours per week shall constitute a week's work. They ask at the same time that their wages may be advanced 2s. per week at once, and that fortnightly payments may be adopted instead of tri-weekly ones as at present.

State of Trade at Newport.—A steamer from Bilbao has brought some iron ore for the Tredegar Company. There has not been much movement in freights except in the iron trade with the United States. The shipments of iron to the West Coast of South America and the United States have kept up well.

State of Trade at Cardiff.—The demand for coal of all descriptions at Cardiff has experienced no diminution. The shipments made of rails are not so heavy as they were in the summer months, but they are still considerable. Iron ore has not presented itself quiet so plentiful.

Bristol and South Wales Wagon Company (Limited).—The directors of this company have determined on returning 1*l.* per share to the proprietors, making the shares 4*l.* paid instead of 5*l.* paid.

The Iron and Coal Workers of South Wales.—On Monday a conference of delegates representing the iron and coal workers of Monmouthshire and Glamorganshire was held at the Old Maypole Inn, Crumlin, to resolve upon a final course of action in reference to a demand recently made for a return of 10 per cent. taken off wages in 1865. There were 22 delegates present, representing 28,470 mining operatives. The following resolution was adopted: "That a vote of thanks be given to those masters who have promised an advance of 10 per cent. on the 1st of January, 1872, but that where the promise has not yet been made a deputation shall wait upon the masters on the 28th inst. with the view of obtaining a definite reply, and that in the event of the concession not being granted, notice be served on the 1st of January next."

Labour in South Wales.—At a conference of delegates representing the colliers and ironworkers of Monmouthshire and Glamorganshire, held at Crumlin on Monday, resolutions were adopted substantially as follows: In the opinion of the meeting long pays are injurious to workmen and to the public generally, and it urgently recommends the adoption of weekly pays without any deduction whatever; that the hours of labour are "far too many," and that every effort should be made to reduce the number to eight out of the twenty-four; that no Mines' Regulation Bill will be satisfactory unless it makes provision for the appointment of practical sub-inspectors and for the entire abolition of the truck system; that the Criminal Law Amendment Act is unjust, and ought to be repealed; and that the members of Parliament for the two counties be asked to support only such a Bill as would be satisfactory to the mining population of the country.

Bridging the Severn.—It is now understood that the Gloucester and Berkeley Canal Company, together with the Severn and Wye Railway Company, have energetically taken up the Severn Bridge Railway (Sharpness) project, and will join the promoters in their application to Parliament for the necessary Act to carry out the undertaking. The Gloucester and Berkeley Canal Company and the Severn and Wye Railway Company have further consented that clauses shall be inserted in the Severn Bridge Railway (Sharpness) Bill, enabling them severally to subscribe 50,000*l.* to the undertaking.

FOREIGN AND COLONIAL NOTES.

Milwaukee Harbour.—This harbour is considered to have been much improved this year. An appropriation of 40,000 dollars was made by Congress this year, being 2000 dollars more than was voted in 1870. The improvement executed this year has consisted of an extension of the piers from the straight cut further out into the lake by about 300 ft. on each pier. The width of the river between the piers is 260 ft. The piers are composed of cribs of heavy timber, 50 ft. by 30 ft., filled with stone.

Southern Mahratta State Railway.—Complete surveys and reports in connexion with the long-talked-of Southern Mahratta State Railway have now been forwarded to the Government of India. A long time has elapsed since this useful undertaking was projected, but it appears to be at last coming to something.

Victorian Railways.—A bogie wagon has been made in the Government workshops at Melbourne for the Victorian Railway. It is, we presume, intended as an experimental one.

Public Works in Queensland.—Operations at a new bridge at Brisbane are being actively prosecuted. The railway lines of the colony are kept in good repair, and a substantial bridge has been completed at a spot on the Main Range, where a landslip occurred some time since. Satisfactory progress has been made with the extension of the inland telegraph lines of the colony, and the construction of an overland line to the Gulf of Carpentaria is being rapidly carried on.

Wooden Railways in Canada.—The legislature of the province of Quebec, Canada, has passed a Bill by which an interest of 3 per cent. per annum is granted by the province on the cost of each mile of wooden railway constructed in it. The cost of each mile is limited to 3000 dols., not including bridges of 150 ft. and upwards, for which an additional allowance is to be made.

American Danger Signals.—Some novel danger signals are now being constructed at every bridge and tunnel on the Hudson River Railroad to warn brakemen who are compelled occasionally to run along the tops of trains on their near approach to dangerous places on the line. A pole is erected by the side of the track, and an arm projects from it at the top over the line. From this arm a wire fringe hangs low enough to strike a brakeman on the front piece of the cap or against the face if he is standing up as the train passes. This notifies to him that he is only 100 ft. from the bridge or tunnel, and must lie down at once.

The Jumna.—It appears to be feared that the Jumna is running dry. In his review of the operations of the Irrigation Department of the North-West Provinces for 1868-69, the Lieutenant-Governor records an observation to the effect that the failing supply of the Jumna renders a reconnaissance of storage sites in the Himalayas advisable, and he specifies the river Tonse as presenting favourable conditions at certain points of its course.

New Zealand Steam Navigation.—A meeting has been held at Pabi, Kaipara, for the purpose of forming a steam company to ply on the Kaipara waters, and it was resolved to petition the provincial Government of Auckland to subsidise the vessels employed. The undertaking is regarded as locally of great importance as forming a connecting link with the Kaipara Railway and Helensville.

An Artesian Well in New Zealand.—An artesian well has been sunk at Avonville, in the province of Canterbury, by Messrs. Grant and Carter, of Christchurch. Water was met with at a distance o between 100 ft. and 200 ft. from the surface; and after three days had been consumed in clearing away sand and gravel, the water supply was cool, clear, and continuous.

A Great Russian Canal.—A project for a canal to connect the Black Sea with the the Caspian has been attracting much attention in St. Petersburg. The project has been for several years a subject of discussion among Russian engineers, but has hitherto been considered impracticable. Recently, however, Captain Blum, of the Russian topographical engineers, having made some extensive explorations, has presented a report to his Government, in which he advocates the construction of the work, which is obviously one of considerable commercial and strategic importance. All the necessary calculations have been made, and it is proposed to carry the canal through the valley of Manitch, supposed by geologists to have formerly united the two seas. The canal, which would pass through several lakes, and run for 50 miles alongside the river Don, would be 450 miles in length; its cost is estimated at 11,000,000*l.*, and its completion would occupy six years.

Important American Enterprise.—A convention of the governors of the New England and North-Western states was held at Detroit on the 27th ult., for the purpose of promoting the construction of a continuous water and steam navigation route from the Mississippi to the Atlantic Ocean. It is proposed to excavate a ship canal round the falls of Niagara, and the route would then proceed by way of Lake Ontario, the river St. Lawrence, Lake Champlain, and the Hudson river to the harbour of New York. Congress is to be petitioned to make appropriations for this great work, and to regulate the rates of toll and transportation.

North German Coast Railways.—A coast railway system for Northern Germany is to be completed as rapidly as possible by the construction of lines to fill the gaps which at present interrupt a continuous line of travel. A road from Tilsit to Memel is to be commenced at once, and when this link is in running order, the completion of a direct line from Bremen to Hamburg will place Memel in direct communication with Emden.

Canadian Railways.—There have been great festivities at Brantford on the occasion of the opening of a branch of the Great Western Railway of Canada from Harrisburg to Brantford. New car-shops of the Grand Trunk Railway Company of Canada have also been opened at Brantford. Sir Hugh Allan is stated to be interesting himself in the construction of the proposed Canadian Pacific line.

The Suez Canal.—The earnings of this canal in the first nine months of this year amounted to 848,120*l.*, as compared with 200,070*l.* in the corresponding period of 1870. The receipts must, however, rise to 650,000*l.* per annum at least in order to enable the Suez Canal Company to provide for working expenses and meet the interest accruing upon its bonds.

Belgian Rolling Stock.—The Great Central Belgian Railway Company is stated to have given out an order for 500 trucks and 20 baggage vans to MM. De Le Court and Company. All available new rolling stock finds a ready outlet in Belgium, the demand for it being extremely pressing. At a recent adjudication at Sarrebruck, M. Carels, of Gand, obtained a contract for two locomotives, having made a lower tender than Herr Wohlert, of Berlin.

An Artesian Well at Boston.—The Boston Gas Company has sunk an artesian well to the depth of 1020 ft. At the last dates, the well was still progressing at the rate of 4 ft. per day.

Water Supply of Sydney.—A good deal of attention has been devoted of late to the question of the water supply of Sydney, New South Wales, the city engineer (Mr. Bell) having presented a report upon the subject. By a series of borings carried out on the Botany Water Reserve, Mr. Bell has discovered a vast underground basin or reservoir, containing water of the purest kind, and naturally filtered through the sand in which it was held. It is estimated that the underground basin will supply 24,000,000 gallons of water per day, and that it holds sufficient for a two years' supply. It is proposed to tap this great natural reservoir by sinking iron cylinders down to the necessary depth in such a way as to form a well.

Railways in Manitoba.—Application will be made in the next Session of the Parliament of Canada for a charter for the Northern Railway of Manitoba, proposed to be constructed from a point at or near Lake Winnipeg to a point within the province in the neighbourhood of Pembina in the territory of Dakotah. Another charter will also be applied for the Western Railway of Manitoba, proposed to be constructed from a point at or near Lake Manitoba to a point within the province in the neighbourhood of St. Joseph or Pembina in the territory of Dakotah.

The Hoosac Tunnel.—This great American work was advanced 260 ft. during October. The figures for November have not yet come to hand, but a great deal of work still remains to be executed.

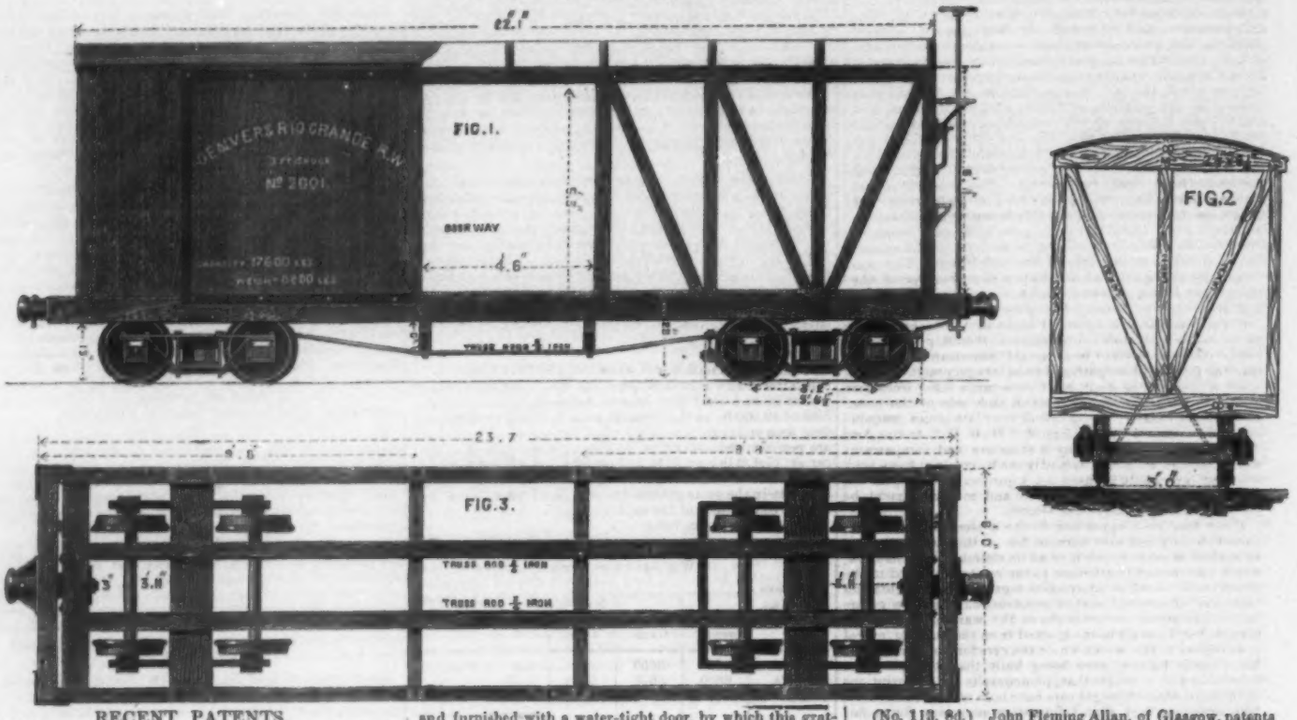
THE INTERNATIONAL EXHIBITION, 1872.—It has been arranged that the new machines for printing, composing, and distributing type, which have been recently perfected at the *Times* printing-office, shall be completely exhibited in working at the London International Exhibition of 1872. The power of rapid production by these several means is probably threefold in advance of any existing modes of printing. The *Mail* newspaper will be printed three times a week, and, if possible, the daily supplement of the *Times*.

SOUTH KENSINGTON MUSEUM.—With a view towards the completion of the collection of water colour paintings illustrating the history of that art, Mr. William Smith, Vice-President of the National Portrait Gallery Trustees, has allowed Mr. Redgrave, R.A., the inspector-general for art, to select from his choice and valuable collection as many rare specimens as in his judgment would illustrate the early period of this truly national art. The works selected by Mr. Redgrave have been presented by Mr. Smith to the nation.

CALCUTTA MUNICIPAL FIRE BRIGADE.—Messrs. Merryweather and Sons have just completed the first steam fire-engine for this brigade. It has a pair of steam cylinders each 6½ in. diameter, and pump each 5½ in. diameter. Its weight is about 35 cwt. with gear. At the trials the following results were obtained: 100 lb. steam per inch 9½ minutes. A jet of water was then maintained 1¼ in. diameter, with steam at 130 lb., and water pressure 100 lb., equalling a distance discharged from the nozzle of 200 ft. The quantity discharged per minute through an ordinary hose was 578 gallons. The Calcutta Fire Brigade has already five fire-engines of Merryweather's make.

NARROW GAUGE FREIGHT-CAR; DENVER AND RIO GRANDE RAILWAY, U.S.A. (3 Ft. Gauge.)

(*For Description, see opposite Page.*)

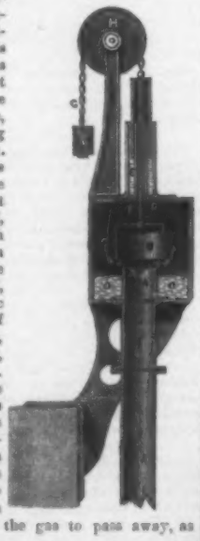


RECENT PATENTS.

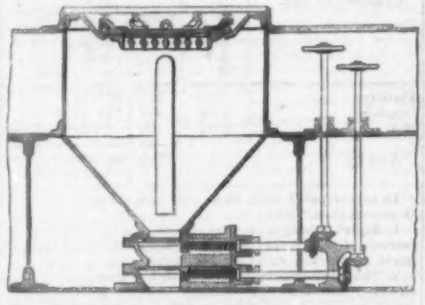
The following specifications of completed patents are all dated within the year 1871; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 85, 8d.) John Franklin Allen, of New York, U.S., patents the arrangement of steam boilers shown in the sketch in the next column. This boiler consists merely of pendulous tubes closed at the bottom and connected at their tops to horizontal tubes, as shown, the pendulous tubes being inclined away from the fire at an angle of about 20 degs., and those above the fire being made about 4 in. in diameter and 4 ft. long, or an equivalent proportion of sectional area to exposed surface. Mr. Allen states that by adopting the above-mentioned position and proportions for the pendulous tubes he obtains the requisite circulation without the employment of any internal partitions or equivalent contrivances.

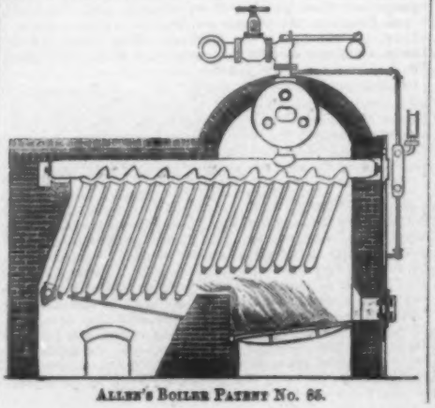
(No. 90, 8d.) Samuel Brother Darwin, of Shrewsbury, patents an arrangement for relieving gas retorts from pressure during the process of distillation. According to this plan, the pressure of the gas generated is turned to account to unseal automatically the mouth of the ascension pipe, one arrangement adopted being shown by the annexed sketch. Referring to this, it will be seen that the mouth of the ascension pipe, A, where it enters the hydraulic main, C, is covered by a bell, B, which is suspended by a rod from another bell, dipping in the water in an annular trough, E, on the top of the hydraulic main. This latter bell is itself partly supported by a chain, G, which passes over the pulley, H, to the counterweight, I. When the retort to which the ascension pipe, A, belongs is out of action the bell, B, dips in the liquid, O, in the hydraulic main, but when gas is generated the pressure of the gas will cause the bell, B, to rise and remain lifted, as shown in the sketch, thus allowing the gas to pass away, as shown by the arrows.



(No. 96, 1s. 4d.) John Phillip Preston, John Theodore Prestige, Edwin James Preston, and William Alfred Prestige, of High-street, Deptford, patent arrangements for discharging ashes, &c., from vessels below the water line. According to these plans the ashes, &c., to be discharged are swept into a receiver having a grating at its upper end, and furnished with a water-tight door, by which this grating can be covered. The bottom of the receiver is furnished with sliding valves, closing openings through the bottom of the vessel, and when the receiver has been charged, and the top cover fixed in place, these sliding valves are opened, and the contents of ashes, &c., blown out through them by admitting to the receiver, through a



pipe provided for the purpose, brine or steam from the boilers of the vessel. In cases where brine is used to expel the ashes, it is preferred to also provide a steam pipe, through which steam can be subsequently admitted for the purpose of expelling the brine. The contents of the receiver being discharged, the bottom valves are closed, and the top cover removed for the reception of a fresh charge of ashes. The sketch above shows the arrangement.



Allen's Boiler Patent No. 85.

(No. 113, 8d.) John Fleming Allan, of Glasgow, patents an arrangement of gas-making apparatus in which a retorr furnace, tar separator, and purifier are united in one cast-iron casing or structure. We could not describe the details of these plans briefly, but we may mention that no hydraulic main is employed, and that the arrangement is designed to expose as little resistance as possible to the exit of the gas from the retorts.

(No. 116, 10d.) John Farrand Clarke, of Moorgate-street, patents arrangements for melting the snow collected from the streets, &c., by introducing it into melting chambers heated by gas! No doubt the gas companies would like to see Mr. Clarke's plans carried out; but we rather fancy that the ratepayers might object to it. If Mr. Clarke had taken the trouble to ascertain what the cost of melting snow in this way would be, we do not think that he would have patented his plan.

(No. 127, 10d.) Robert Heddle Leask, of 21, Eden Quay, Dublin, patents an arrangement of steam reversing gear for large engines. In this arrangement the reversing motion is obtained by the direct action of a steam piston, the motion of this piston being controlled by regulating the flow of water from one to the other of two hydraulic cylinders, the plungers of which are so connected to the steam piston rod that one plunger enters its cylinder as the other moves outwards from its cylinder, and *vice versâ*. The arrangement is similar in principle to that adopted for moving the saws in Messrs. Cowans, Sheldon, and Co.'s rail-sawing machine, illustrated by us on page 355 of the present volume.

(No. 128, 1s. 10d.) John Clark, of 8, Belmont-terrace, Kensington, patents improved arrangements of his well-known continuous railway brakes. We could not describe these new plans briefly here; but we shall take some future opportunity of giving an account of them.

(No. 143, 10d.) Peter Brotherhood and George Dominicus Kittoe, of 56, Compton-street, patent some very neat arrangements of governors for steam engines, &c. As we intend to illustrate one modification of these governors shortly, we need not describe the plans here.

(No. 149, 10d.) William Robinson, of Old Bailey, patents an arrangement of furnace for puddling by mechanical means. According to this plan the bed of the furnace is so mounted on an axis that it can be inclined alternately in opposite directions, and the metal be thus thrown or rolled from side to side. The only novelty of the plan appears to consist in the constructive details adopted.

(No. 150, 8d.) George Warsop, of 9, Burton-street, Nottingham, patents arranging the air pumps of aëro-steam engines, so that they serve both to draw air from the condenser, and force it into the boiler.

Indus Valley Railway.—Major Bowes, R.E., officiating Deputy Consulting Engineer and Assistant Secretary to the Government N. W. P., in the P. W. D., railway branch, has been appointed to the Kotree district of the Indus Valley Railway. Major Bowes is to have the rank of officiating superintending engineer.

NARROW GAUGE FREIGHT-CARS.

THE following letter on the weight of narrow-gauge rolling stock has been addressed to our contemporary, the Chicago *Railroad Gazette*, by Mr. Schuyler, the secretary of the Denver and Rio Grande Railroad, a line of 3 ft. gauge, to which reference has on several occasions been made in our pages. The importance of many of the facts stated by Mr. Schuyler, and the great interest taken at the present time in the matters dealt with in his letter, induces us to republish the latter in our pages. It was our intention to have at the same time reproduced from the *Railroad Gazette* an editorial article in which our contemporary deals with the arguments advanced by Mr. Schuyler; but the demands upon our space compel us to defer the publication of the article referred to until next week; when we also shall have something to say on the matter under discussion.

To the Editor of the Railroad Gazette.

Sir,—It had not been my intention to write or print anything further upon a subject which has so many able advocates and about which so much has already been written, until such time as the completion of some of the many narrow gauge roads now under construction should place in our hands statistics derived from actual American practice to take the place of those gathered from foreign practice, which, however valuable in itself, must necessarily differ from ours as widely as the broader systems on each side of the ocean have always differed; but in one of your late issues containing a criticism on a letter signed "H. B. W." to the *New York World*, I notice many statements and comparisons which, though no doubt honestly made, coming from such a source, are likely to have an injurious effect upon the minds of those accustomed to read and to some extent be guided by the opinions of the *Gazette*.

Heretofore your opposition to the system has been conducted cleverly and with fairness, but in this article there is an evident attempt to rob it of all its claims to consideration, which I am bound to attribute to the reasons assigned in the article itself—want of information regarding the weights and capacities of cars and cost of construction of narrow gauge lines. The article certainly shows the want of such information, but I should have expected from the visits of one of your editors to the works where the cars for the Denver and Rio Grande Railway were being built that it might have been otherwise; besides that, photographs and descriptions of the four-wheeled freight cars have been widely distributed. But, since you lack that information necessary for a fair discussion of any subject, I feel it is necessary, as far as time will permit me, to supply it, in order that you may be better guided in any future articles towards that fairness of comparison exacted from the advocates of the narrow or 3 ft. gauge.

You claim, and very justly, that all cars for the narrow gauge should only be compared in point of strength, weight, capacity and cost with corresponding cars for the broad gauge. As the great majority of the cars in use on American roads are eight-wheeled bogie-truck cars, I agree with you fully in thinking that all comparisons should be made with them. The accompanying drawing shows (see opposite page) the general plan of an eight-wheeled car for the 3 ft. gauge—one of a set but just finished for the Denver and Rio Grande Railway. We solicit your very careful consideration of it. Being the first yet built for this gauge, is likely, of course, to have many imperfections. I do not, therefore, present it as a model, but merely as an illustration of what may be done with that class of stock on the 3 ft. gauge, and of the justice of the comparisons which have been already made. The dimensions of this car are as follows:

Length of frame over all	23 ft. 7 in.
Width	6 „ 0 „
Height of floor above rail	2 „ 4 „
Length of box	22 „ 1 „
Width of box outside	6 „ 2 „
Height in centre	6 „ 0 „
Diameter of wheels	20 „
Angle of stability empty	56 degrees
„ „ loaded with 11,800 lb. cotton	38 „
Angle of stability loaded with 17,600 lb. wheat	51 „
Floor area	132 sq. ft.
Cubic space in box	792 ft.
Weight	8,800 lb.
Capacity	17,600 „
Proportion of dead to paying weight	1 to 2

The dimensions of each part of the car are given, so that whosoever will may calculate, each in his own fashion, the weight and strength of the car. The weights here given are taken from the scale records at the shops and vouched for by the makers as correct.

The weight given for oak seems light, but it is the average of all the dressed oak used in the car, the material being the best Pennsylvania white oak.

No. feet oak, 860, at 4 lb. per foot	3400
„ pine, 515, at 2 lb. „	1030
Wrought iron, steel, brass, and rubber	1300
Cast iron	910
Wheels and axles	2080
Total	8790

The capacity of the box-car is given by the makers as 16,000 lb., while that of the platform having the same strength is placed at 19,000 lb., for the reason that they deemed the box too small to hold more than that amount of general merchandise.

There are but very few articles, however, of general traffic of such bulk in proportion to their weight that they would fail to load the car to its full capacity of 17,600 lb., as here given. One of these is cotton, which has an average weight in bale of about 15 lb. per cubic foot.

With this freight the capacity of the car would be limited to 11,800 lb. This is a proportion of dead to paying weight of 1 to 1.34, so that it would still have a great advantage over the broad gauge, even for this exceptionally light and bulky weight.

For roads where the traffic should be largely in cotton a much larger car could easily be built 7 ft. wide and weighing 9000 or 9500 lb., which would still maintain the proportion of one dead to two paying weight.

For purposes of comparison I propose taking a Pennsylvania Railroad car built by same makers, the heaviest and strongest made for that road—a car having a varying weight of from 18,000 to 20,000 lb., and capacity limited to 20,000 lb. The floor is supported by seven stringers, the two outside 4 in. by 8 in. each, the five intermediate ones 3 in. by 7 in. each, with a clear span of 18 ft., trussed by three ¾ in. rods passing under two 3 in. by 9 in. corbels supporting the stringers. The weight of this car loaded will average, say, 39,000 lb.

The floor of the 3 ft. car above, as will be seen, has but four stringers, the two outside being 4 in. by 8 in. each, the two intermediate 4 in. by 7 in. each, having clear span of 15 ft. and trussed with two ¾ in. rods passing under two 3 in. by 9 in. corbels as above.

The box framing will compare favourably in point of strength with the heaviest cars for the broad gauge, and is 20 per cent. stronger than that of the great mass of cars in daily use.

A simple calculation will show the platform strength of this latter car as compared with the first to be as 95 to 100—that is, on a total floor area of 132 ft. it is as safe with a load of 19,000 lb. as the Pennsylvania Railroad car having a floor area of 221 ft. is with a load of 20,000 lb. I think we are perfectly safe, therefore, in placing the capacity of this car at 17,600 lb., or 2 to 1 of weight. A platform and a gondola are the other cars belonging to this set. They are of precisely the same pattern and size in all respects, excepting, of course, that of the superstructure. A tabular statement will show them better:

Classes of Cars.	Weight in pounds. Running gear.	Platform.	Superstructure.	Total.	Capacity.
Platform	2600	3650	...	6250	19,000
Gondola	2600	3650	1000	7250	18,000
Box	2600	3650	2550	1800	17,600
Average	...	...	...	7443	18,200

Classes of Cars.	Gross load on each wheel.	Cost. Total.	Cost. For 1000 lb. capacity.	Proportion of dead to paying load.
Platform	3156	350	$18 42	1 to 3.04
Gondola	3156	385	21 39	1 to 2.48
Box	3300	450	25 71	1 to 2.00
Average	...	395	$21 16	1 to 2.45

To be compared with their peers on broad gauge roads these cars should have:

1. Equal strength in proportion to the load to be carried. I submit that they have that equal to the best cars made.

2. That they shall have equal capacity for speed. To have this they must have equal strength of framing throughout to resist the jolting and strains. The drawing will show that they have this.

They should also have an equal angle of stability. As noted above, we have an angle empty of 56°, loaded with wheat, 51°. The usual angle of stability for a broad gauge car is from 35° to 45°. Certainly they are at no disadvantage in this respect.

The axle friction should be no greater than on the broad gauge. With 20 in. wheel and 2¾ in. journal at 20 miles per hour the speed of the axle is 223 ft. per minute. Most broad gauge cars have wheels of 30 in. diameter and journals of 3½ in. diameter. At 20 miles per hour their speed would be 205 ft. per minute. If we substitute 24 in. wheels for the 20 in. wheel now used for the narrow gauge cars, which can be done at the slightest possible increase of weight and still retain an angle of stability as great as the broad gauge car, the speed of axle would be but 186 ft. per minute.

A serious impediment to speed and detraction from power of engine is found in the flange friction and sliding of wheels on curves owing to difference in length of inner and outer rails. For the 3 ft. gauge this is reduced about 30 per cent.—a most important advantage in lines having considerable curvature. I believe, then, that this point of speed may be readily conceded.

3. That the cost of cars shall be no greater for their tonnage. The average cost of the three classes of cars, box, gondola, and platform, for the 3 ft. gauge, is 21 dols. 70 cents per 1000 lb. capacity.

The average cost of corresponding cars for the broad gauge (4 ft. 8½ in.) is 32 dols. 25 cents per 1000 lb. capacity, or nearly 50 per cent. greater than for the 3 ft.

So it will be seen that in no point of comparison do these cars suffer, while in many which are vital to the transportation interest of the country they so far excel as to be beyond comparison.

The following comparative statement will show these things more plainly:

Style of Car.	Weight in pounds. Gauge 3 ft.	Gauge 4 ft. 8½ in.	Capacity. Gauge 3 ft.	Gauge 4 ft. 8½ in.	Cost in 1871. Gauge 3 ft.	Gauge 4 ft. 8½ in.
8-wheeled box	8800	12,000	17,600	20,000	$450	$735
8-wheeled platform	6250	18,000	19,000	20,000	350	575
8-wheeled gondola	7250	18,500	18,000	20,000	395	625
Average	7450	18,500	18,200	20,000	$395	$645

Style of Car.	Cost per 1000 lb. load. Gauge 3 ft.	Gauge 4 ft. 8½ in.	Proportion of dead to paying load. Gauge 3 ft.	Gauge 4 ft. 8½ in.
8-wheeled box	$25 58	$36 75	1 to 2	1 to 1.05
8-wheeled platform	18 42	2 75	1 to 3.04	1 to 1.11
8-wheeled gondola	21 38	31 25	1 to 2.48	1 to 1.08
Average	$21 70	$32 25	1 to 2.45	1 to 1.12

Saving in dead weight of cars to carry 100 tons freight ... ... 108,000 lb.
Saving in cost of cars to carry 100 tons freight ... $2110

Nearly a hundred of the four-wheeled cars are in daily use upon the Denver and Rio Grande Railway carrying iron and other construction material. To carry iron, as they are short cars, a swing bolster is placed across the centre of the car and two are coupled together, the iron resting on the bolsters. Each car weighs 3500 lb., and carries 10,500 lb. of iron (21,000 upon the two). It is the severest load with which any car can be tested, but it is carried with perfect ease, the cars running so steadily and smoothly over a smooth track, as yet unballasted, with heavy gradients and sharp curves, as to be a subject of remark by every one who sees them. Railway men especially remark the nearly perfect freedom from flange friction on curves, which would cause the cars upon the broad gauge to grind very badly. I should certainly like to see a train made up upon the broad gauge of any cars which would weigh so little and do so much as these, and a description of such would be of very great benefit.

Unfortunately for us, delays in the arrival of iron for the Denver and Rio Grande Railway (which is now, however, on hand) have prevented the completion of the line and delayed the experiments which were proposed to be made when the work of construction should be finished, which will account for the meagre information regarding the operation of this line.

It seems a little strange that, while crying out against unfair comparisons, you should yourselves have selected as an offset to the passenger cars built for us by Jackson and Sharp, such a car as the one mentioned in use on the New Jersey Railroad. Nowhere else could you have found a car so frail or devoid of ornamentation as the one you cite, which is in use only as a smoking car, or second-class car on the local trains between New York and New Brunswick. I cannot recal in my journeys through the country anything fit to compare with them.

If disposed to deal fairly, why not cite our smoking car, which gives as much room as the New Jersey car and weighs but 307 lb. per passenger, and costs but 58 dols. per passenger; or, if not so magnanimous, make due allowance for the two water-closets, the partition in the centre and stove space, which are wanting in the New Jersey car, and which allowance would give more room per passenger than the New Jersey car, while bringing weight and cost for this first-class handsome car below that of the poorest of broad gauge rolling stock.

If we had chosen to run such cars as the one quoted, we could have built them for a weight of 320 lb. per passenger, with the allowance of 33 in. by 19 in. space claimed for the New Jersey car; but every one who saw these cars for the Denver and Rio Grande Railway as they left the shop will admit that, in point of finish, they were worthy of comparison with the best day cars made.

It is a mistake which all opponents of the narrow gauge make to suppose that the lightness of these cars arises from a frailer style of construction than those in ordinary use which are so heavy; but that this is not so any one who takes the trouble to estimate the relative strength of the car framing given above, and that of any, even the heaviest, car in use on broad gauges, may readily see. I have not just now the data at hand, nor the time to make as full comparison of these cars with those of broad gauges as I would like. I would rather show side by side the weights and comparative strength of each detail of the two systems. Such a comparison would show more plainly than any explanation all the advantages afforded by the 3 ft. gauge for car construction, and where the great saving in weight is obtained. The deductions to be drawn from the foregoing statement of weights and capacities, and from a thorough examination of the drawing are:

1. That the strength of these cars, their capacity for resisting shock and strains, as compared with the best cars in use on the 4 ft. 8½ in gauge, is as 95 to 100.

2. That their actual carrying capacity is in the same proportion.

3. That their capabilities for speed are in same proportion.

4. That with all these, the average weight of the three styles of care given above on each system bears a proportion of but 39 for the narrow gauge to 100 for the broad, with a proportion of cost but 67 to 100.

Now, as it is from freight that new roads west of the Mississippi must chiefly look for support, I think we might well eliminate the passenger question from this discussion; but, if you please, we will compare our passenger cars with such as are in use on the Pennsylvania Railroad, Pittsburgh, Fort Wayne and Chicago, Hannibal and St. Joseph, Kansas Pacific, and many other first-class roads. A car which has a weight of 36,000 lb. to 38,000 lb. costs 6000 dols., and seats 53 passengers, giving them 19 in. width and 33 in. between seats. This is a weight, per passenger, of 675 lb. and a cost of 113 dols. To give the passengers on the Denver and Rio Grande Railway the same room, we should take out the partition, reduce number of passengers to 32, and have a car weight of 408 lb. and cost of 100 dols. per passenger. The height of the cars is already much greater than those on foreign roads, and is sufficient to allow perfect freedom of movement for the tallest persons. The ventilation is also as perfect as in any cars in use. After witnessing the results obtained on these, the first of the kind ever built, I have no hesitation in saying that all the comforts desirable for passengers on the longest routes can be obtained in the narrow gauge cars, without exceeding, even if equalling, the weight and cost of the broad gauge cars.

These questions have been discussed so long that I believe it is evident to all that that four-fifths of the roads already constructed in the United States are operated with rolling stock having its weight so disproportioned to the amount of traffic that the expense of constructing lines for it to run upon, and the subsequent heavy expense of operation involved by its use, is a waste of money almost criminal in those parts of our country yet unsupplied with railways, where capital as well as traffic is small, and where it can always find so many more profitable uses than that of being sunk in the construction of lines where the very excess of capital employed must defeat the objects for which the line was built, retarding instead of accelerating the development of the country.

One plan by which to remedy this has at one time or another been a favourite one with probably nearly every engineer in Christendom. They have all said: "Of course rolling stock is too heavy. Build it lighter and lighter lines can be made upon which to run it, which will be paying railways even with the smallest traffic;" and such lines have been constructed, retaining the existing gauges, under the natural belief that transfers were to be avoided, but disappointment has resulted in almost every case, whether in Europe or this country, because the light rolling stock when transferred to other lines would not stand the heavy shocks and strains on the heavier roads, and the lightly built lines would not support the heavy pounding weights of the heavier rolling stock, so that the lines very soon lapsed into the old system. The tendency has constantly been toward heavier rolling stock, though their loads have not been correspondingly increased, and just so long as roads are built wide enough to permit such disproportions of car weight and freight as now exists, just so long will these disproportions increase, and lines must be constructed heavy enough to support them.

But even were it possible to restrain this tendency toward increase of weight on present gauges, it has not by any means been proved that it would be the best for the new system which must be developed in the unoccupied countries west of the Mississippi.

The history of the narrow gauge and its advantages has been too often discussed to need any repetition. It has furnished a solution for nearly all the difficulties with which engineers had to contend in the building of light railways, and its advantages have become so apparent in its long trial abroad as to threaten to revolutionise the whole system of railroads, instead of being, as its first advocates claimed, adapted to the wants of particular sections and districts. No better proof of its merits could be found than in the opposition it meets among those fearing rival roads. To counteract its increasing popularity the old principle of light construction on broad gauges is revived. The surprising part of this is, that it should meet with support from the *Gazette*.

Compared with the 3 ft. gauge, the points claimed for this revised theory are, as near as I can gather:

Nearly equal economy in construction of line.

The same advantages of light rolling stock.

The avoidance of transfers.

Greater angles of stability and consequently greater steadiness for its cars.

In support of this theory you give in your issue of August 23rd, a comparative estimate of the cost of a road upon this plan and one of 3 ft. gauge.

I will confess that in an examination of this estimate one can hardly believe it to be the work of a sound or experienced engineer, and is naturally puzzled to know how it could have passed into your columns without more careful criticism. A still more surprising thing is that you should have soberly commended it and that the *Scientific American* should, in reproducing it, be so overcome by its plausibility as to forget its usual caution and strike out savagely in regard to what it terms "a narrow gauge bubble." Now while the article in the *Scientific American*, which is justly headed "nonsense," is simply amusing in its absurd decisions as to what will be the effect of this estimate, it is no less intended to do the narrow gauge interests much harm.

It certainly has not been shown, nor do I think it can be, that "many of the items set down" in that estimate "as equal in cost" will be the same in both cases.

For instance, the item of graduation, in which but 6 per cent. difference in cost between that necessary for 4 ft. 8½ in. and that for 3 it. is shown.

I should very much like to see the country where an engineer could construct a safe road bed for a 4 ft. 8½ in. track at a cost of but 6 per cent. greater than one which would be perfectly secure and most economical for a gauge of 3 ft. The nearest approach to it would be, perhaps, on some parts of the great plains in the far west, where the cost of one being little or nothing, the increase of the other would be expressed in same terms. But if we take that extreme, take the other also. I know of many miles of country through which railways already projected and building must pass, in the mountains of Colorado and New Mexico and through the elevated table lands of Arizona, where the increase of cost would be more than 50 per cent., and in some cases more than 75 per cent., over that for a 3 ft. gauge, without making any allowance for the sharper curvature permissible on the 3 ft., and which the desirable feature in the broad system, the avoidance of transfers by running over the line the heavy rolling stock of other roads, would prevent. Miles of country nearly as bad exist in Pennsylvania, Virginia, Tennessee, South Carolina, Georgia, and other states, which in the near future must be traversed by railways under the increasing demand for cheap transportation, where the difference in cost of graduation will range from 25 to 30 per cent., allowing the cheapest possible construction for the broad system.

The item of masonry is also set down as equal in cost for both gauges.

That should certainly have required a little explanation. Is it possible to build a culvert through or under a broad bank at no greater cost than through or under a narrow one? Or, since always it is contemplated to run over this line the wider and heavier rolling stock of other roads, would an engineer build any piers for bridges as narrow as those for a 3 ft. gauge, where no such transfer is contemplated? Or would the bridges themselves be made no wider or heavier than for the 3 ft. gauge where no heavy rolling stock is proposed to be run upon the line?

Some regard for another apparently desirable feature of these light roads—the gradual adoption of heavy rolling stock—would, I think, also demand that engine-houses, machine and car shops, &c., being permanent structures, should be made large enough to accommodate the future engine and car. None of these things enter this estimate, which is so full of such omissions and inaccuracies that any further criticism of it would be wasted time. Suppose we allow that it is possible for the estimate to be correct (which certainly is a great moral concession) and that on this light railway the same small tunnels, narrow bridges, light rails, &c., are used; such at least as would be perfectly secure for the 3 ft. gauge. It is claimed that the only difference in weight and cost of rolling stock would be that arising from increased weight and cost of axles. In other words, all the stock adapted to and built for the 3 ft. gauge would be used on this broad gauge; that is, they would retain one of the greatest disadvantages of the old system—the long axles, with their heavy dragging around curves, greatly detracting from the power of engine, and combine with it, what they have all along maintained to be the disadvantage of the narrow gauge, the narrow car body. And for what purpose? Simply that they may have a greater angle of stability for their cars, and that their rails may be far enough apart to avoid the necessity of transfers by running over their line the loaded cars coming to them from other lines.

It would not be reasonable to suppose that with the small wheels of the narrow gauge many of their own cars would find their way on other lines; therefore, the bulk of the traffic must still be transferred, even after this sacrifice to prevent it, or else the large wheels and heavy truck-frames of the large car must be adopted at a considerable increase of weight and cost, for which in the estimate no provision is made. As to angles of stability, since it is commonly assumed and practiced that 38° to 45° is perfectly safe at any ordinary speed, and it is shown that the 3 ft. gauge possesses 45° to 50° loaded and 56° to 90° empty, I can hardly understand why any great sacrifices should be made to obtain a greater. Truly, then, the great advantages to be derived from this broad gauge, lightly-equipped system are as stated, that one-way transfers can be avoided. But how will the attempt to run an ordinary car over such a road affect it? Before it can be done the whole line must be rebuilt—tunnels and cuttings enlarged, piers rebuilt and bridges made wider.

Where, then, does this estimate of cost stand? Then a loaded freight car from a heavier line passes over this 30 lb. rail and hammers it with 5000 lb. per wheel, a force equal to that of the engine. A Pullman car is placed upon it and pounds it with 30 tons of dead weight. No engine from any other line may pass over it, or what is the result? Simply a bending of the rails to such an extent as to render it unsafe for use until the rails over the entire line are renewed. It cannot cross a bridge without inflicting an unsafe strain. Why, then, the bridges must be made heavier. The simple effect of all this is that in a short time the line has lapsed to the old system. All the advantages to be gained from the light rolling stock are lost, and the line has been rebuilt at a cost far exceeding what would have at first been necessary. The narrow gauge is at least safe from any such disasters as this, and will go on making equal speed, carrying as great a quantity of freight and doing it at a cost of two-thirds that for which its heavier rival can possibly carry it, and above all making dividends instead of assessments.

In making such an estimate as this, why is it that the cost of a representative line on the narrow gauge is overlooked? The *Gazette* says it declines to accept a casual newspaper paragraph regarding the cost of the Denver and Rio Grande Railway as reliable. I do not know what paragraph it refers to, but in a circular of June 25th I gave the comparative cost of two railways built under the same engineering supervision and having in all respects a similar plan of constructions through the small character of country (that through which the narrow gauge runs being, if anything, the most difficult), and having the same curvature and nearly equal gradients. The cost of the one on the 4 ft. 8½ in. gauge, viz., the Denver extension of the Kansas Pacific Railway, being 29,500 dols. per mile, and that on the 3 ft. gauge, the Denver and Rio Grande Railway, being 13,500 dols. per mile, including equipment.

Having occupied somewhat responsible positions in the construction of both these railways, with full knowledge of their details, I think these figures at least may be accepted as reliable.

The trains of the Denver and Rio Grande are every day making as good speeds as are made on the average of Western roads, freight trains running at 10 to 15 miles per hour, while passenger trains have repeatedly been run at speeds of 28 to 35 miles per hour, with as certain safety and ease as were ever insured to the trains on broader gauges. The difference between the two system, viz., narrow gauge and broad gauge, with light equipment, is that which both have started with equally favourable auspices; one has been tried and abandoned, the other, the narrow gauge, inaugurated in Norway (after a thorough trial and abandonment of the light equipment for the broad gauges), has since progressed in favour steadily until the present time.

To-day we have on record the organisations of some forty-five lines of railway in the United States alone with 3 ft. gauge, aggregating 10,000 miles in length, and backed by some of the best railway men of the country, on nearly every one of which work has been commenced, and is being prosecuted rapidly.

A singular feature of the argument of the broad-gauge light railway advocates is that they persist in denominating the narrow gauge a theory, while claiming for their own views the merits of practical success. It is a transmutation of terms that would be amusing were it not perpetrated by parties whose every word on such subjects should have weight. The narrow gauge has been tried and operated successfully too long to be called a theory now. Its merit is its practical success wherever tried; whether for general traffic in Norway, Russia, Tasmania, and Wales, or for purely mineral traffic—the hauling of slag from furnaces and coal from mines in this country, and, so far as tried, for general traffic on the Denver and Rio Grande Railway, the first in the United States.

The light equipment for broad gauges was tried in Norway. Failing in that, they found success in the narrow gauge. Light equipment for light broad roads has been used in England for branch lines, and found wanting; it has been tried repeatedly in this country, and abandoned under the universal tendency to increased weight and strength in all classes of rolling stock. Which, then, is theory, and which has the practical value?

The narrow gauge starts with its rolling stock as strong in proportion as the heaviest of the broad gauge, and its gauge saves it from any tendency toward further increase of weight.

In face of all this and of the hearty indorsement of the 3 ft. gauge by such eminent engineers and railway managers as John Edgar Thomson, Samuel M. Felton, Thomas A. Scott, and a host more of the best and most thoroughly practical railway men of this country, whose names, on account of their present identification with broad gauge, I am not at liberty to quote, and in face of the reports of commissions appointed especially to consider its merits and composed of such men as those who sat on the Imperial Commission of Russia, and those of the Indian Commission, which decided on the metre (3 ft. 3⅜ in.) as the gauge for a 10,000 mile system of railways in India, after a thorough trial of this broad gauge, light equipment system: even so good a paper as the *Scientific American*, in presenting the estimate from the *Gazette* of August 23, before spoken of, characterises the narrow gauge system of railways as a "bubble" and predicts its speedy collapse. Now I have no claim to sit in judgment upon the editor of that paper, but I certainly must be permitted a doubt as to his being a man of sounder judgment or more practical experience in railway construction, or more reliable on general railway matters, than thousands of the men whose opinion is directly opposed to his, indorsing the narrow gauge as emphatically as he condemns it; and, in a modest way, I would beg to suggest to him than in presenting and indorsing such an estimate as the one given, where the only difference he could see in cost of rolling stock was to be in the cost of axles to the extent of 9 lb. per car, he should not accompany it with the statement that the public will demand wide cars, for wide cars do most certainly involve more weight and cost in proportion to capacity, beyond that for a narrow gauge, than that included in the item axles, and just as certainly do they involve an increased size and cost of bridges and masonry, of cuttings and tunnels, of engine houses and shops, unprovided for in the estimate; and I would also ask him, as well as the *Gazette*, since both papers from their able management and wide circulation have great influence in forming the opinions of a large portion of the people of the United States upon such subjects, if it would not be better to wait until the roads now approaching completion in this country shall have demonstrated the truth or falsity of their claims by practical operation, before deciding so summarily what the people will demand; and that they may investigate the capabilities of the narrow gauge for comfort more thoroughly than either appears yet to have done, before deciding that the people will demand any more than they can easily obtain on the 3 ft. gauge.

It certainly at this late hour did not need a prophet like the *Scientific American* to divine that light railways for light traffic would probably be the next phase of railroad engineering, but it did require considerable assurance to proclaim so decidedly that it was not to take the shape of narrow gauges.

Long ago the people demanded cheaper transportation, and were given as the change to be desired the kind of light line you now propose. It was a partial remedy, however, too weak to hold its own. We have progressed since then and have discovered the cause of failure.

Now when the demand is repeated more loudly than ever, engineers are ready with a nearly perfect system, which merits something more than the caustic commentary "bubble." A system which promises to double the facilities and halve the cost of transportation. Surely it were wiser to give the widest encouragement to such plans, instead of answering the cry with a resurrected failure; to gain more credit for reliability, to become safer guides for the masses by a thorough investigation of the merits of plans already so strongly supported, instead of ruthlessly condemning them in face of established facts.

Howard Schuyler.

JARROW SHIPBUILDING WORKS.

THE iron shipbuilding works belonging to Palmer's Shipbuilding and Iron Co., at Jarrow-on-the-Tyne, are too well-known by name to require any special introduction; the important position, however, which that firm held in connexion with iron shipbuilding in the earliest years of its introduction, deserves more than a passing notice, for although not actually the first to construct such vessels, Messrs. Palmer were amongst the earliest to recognise the importance of the revolution which has since been accomplished in the transformation of the "wooden walls" into the "iron walls of old England." The history of iron shipbuilding on the Tyne commences from the year 1840. In March of that year, the John Garrow, of Liverpool, a vessel of 800 tons burthen, the first iron ship ever seen on the Tyne, arrived at Shields, causing there no small excitement. A shipbuilding firm at Walker commenced to use the new material almost immediately, and, on the 23rd September, 1842, the iron steamer Prince Albert glided from Walker slipway into the waters of the Tyne. During the next eight or ten years very little progress was made. The vessels mostly in demand were colliers, and no one thought of applying iron in their construction; but, about the the year 1850, the carriage of coal by railway began seriously to affect the sale of north country coal in the London market, and it became necessary, in the interests of the coalowners and others, to devise some means of conveying the staple produce of the Newcastle district to London in an expeditious, regular, and, at the same time, economical manner. To accomplish this object, Mr. C. M. Palmer caused an iron screw steamer to be designed in such a manner as to secure the greatest possible capacity, with engines only sufficiently powerful to insure her making her voyages with regularity. This vessel, the John Bowes, was laden with 650 tons of coal in four hours; in 48 hours she arrived in London, in 24 hours she discharged her cargo, and in 48 hours more she was again in the Tyne, so that in five days she performed successfully an amount of work that would have taken two average sized sailing colliers upwards of a month to accomplish. In the year following the launch of the John Bowes, the first iron vessel built on the Wear, was released from its blocks, and the Tees soon followed the example of her two sister rivers. The James Dixon, which was built at a somewhat later date, made 57 voyages to London from the Tyne in one year, delivering 62,842 tons of coal, with a crew of only 21 persons. To accomplish this work on the old system with sailing colliers, would have required 16 ships and 144 hands to man them. One of the great difficulties encountered in perfecting these vessels was in the ballasting. To dispense with the necessity of shipping shingle or chalk as ballast, many costly experiments were tried, and at length by a system of double bottoms, the ballasting of the vessels with water was brought to a highly satisfactory result. Besides accomplishing the purposes for which they were designed, these screw colliers proved capable of rendering very important services to the Royal Navy during the Crimean War. When, in the latter part of 1854, information reached this country that the commissariat department of our army in the Crimea had broken down, it was found that screw colliers were admirably adapted for the work, and the majority of them were temporarily taken out of the coal trade and employed in the transport service.

The first iron vessel for war purposes constructed on the Tyne was the Terror, one of the large iron cased floating batteries designed during the Russian War to operate against Cronstadt. This vessel, of 2000 tons and 250 horse power, carrying twenty-six 68-pounder guns, was built in 3½ months, and she would have been completed in three months had not the declaration of peace slackened the energies of the men employed on her construction. It was in the building of this vessel that rolled armour plates were first used. The demand for forged armour plates was so great that all the forges in the kingdom could not supply it, and recourse to rolling was unavoidable. At that time the largest plate mill was at Parkgate, and Messrs. Palmer accordingly employed Messrs. Beale and Co., the owners of Parkgate Works, to roll the plates they required. To the use of these rolled plates, however, the Admiralty opposed itself, whereupon Messrs. Palmer invited them to a trial of the comparative efficiency of forged and rolled plates. Without following out the experiments, we may here briefly state that the results of them showed that whilst hammered plate split and cracked to pieces, the rolled plates were not broken, only indented, and were superior to the hammered plate in every respect. To Messrs. Palmer may, therefore, justly be accorded the credit of having introduced rolled in lieu of hammered armour plates, and of having proved both their strength and utility. Indeed, they were subsequently for some time known and spoken of in Parliament as "Palmer's Rolled Plates."

Having now briefly placed on record the important position which the firm of Messrs. Palmer and Co. are entitled to, not only with reference to the introduction of iron shipbuilding generally, but also in connexion with the important improvements introduced by them in the construction of armour plates, we propose to give an account of the present state of their works, which constitute by far the largest shipbuilding yard on the river Tyne. In no yard, besides this one, can it be said that the iron ore is introduced at one end, and after passing through the various shops and works extending over a river frontage of upwards of a mile, launched into the river a fully equipped steam vessel. Such, however, is the case here, and the entire operations of smelting, puddling, rolling, casting, fitting, turning, boilermaking, and shipbuilding can be successively traced during a walk from one end of the works to the other. The greater portion of the ironstone employed is obtained from mines belonging to the firm. At a point on the coast, ten miles north of Whitby, the ironstone seam crops out in the sides of the cliffs, and here Messrs. Palmer have formed the small harbour of Port Mulgrave where vessels can ride in safety, and ship their cargoes with ease and expedition. From these works they draw above 250,000 tons of mineral each year. At Jarrow, the ore is delivered to the furnaces by means of Armstrong hydraulic cranes and mixed with ores from Cumberland, Devonshire, and Lincolnshire, thence it is passed to the mills, and from the mills to the shipyard. The works are supplied by rail with coal and coke from the coal-fields of Durham, by Messrs. John Bowes and Company, and the quantity of raw coal raised for their supply is upwards of 1000 tons per day. There is a branch railway on to the North-Eastern Company's line, which places the works in communication with the whole railway system of England and Scotland.

Beginning at the west end of the yard, or at the part nearest to Newcastle up the river, we come to the blast furnaces which are situated at the extreme end of the premises, abutting close upon the boundary wall. Of these there are four now in blast, all 60 ft. high, and a fifth is in course of erection which will be 20 ft. higher. There are two blowing engines in separate houses, one having a steam cylinder 40 in. in diameter, with a 9 ft. stroke, and a blowing cylinder 9 ft. in diameter. The second consists of two cylinders each 52 in. in diameter, with 9 ft. stroke, and two blowing cylinders 8 ft. 4 in. in diameter. The blast, which issues at a pressure of about 4 lb., is heated by passing through stoves in the usual manner. There are in all 16 boilers all heated by the waste gases of the blast furnaces. Next to these furnaces comes the forge. Here there are 77 puddling furnaces, 4 cinder furnaces, and two ball furnaces. Two of the puddling furnaces are fitted with mechanical puddling machinery, driven by a small independent engine. There are five steam hammers, of 3 tons weight each, for making the puddle balls into blooms, and there are two trains of rolling mills, consisting of four pairs of rolls each, for preparing the blooms for the plate rolls. There is also a shearing machine for shearing the puddle bars whilst hot. In the mill shed there are two trains of plate mills, containing two sets of rolls in each, driven by an engine, with reversing gear, placed between them. These mills will roll plates from $\frac{1}{16}$ in. to 4 in. in thickness. There are five furnaces attached to each train. The bar mill consists of three furnaces and a train of rolls with their engine; and alongside of this there is another train of rolls, used for rolling plates or angle irons, consisting of four sets of rolls, to which are attached five furnaces. At the further end of this shop are two shearing machines, each capable of making a single cut 7 ft. in length; two bar-straightening machines, and circular saws for cutting off the ends of the bars. In the iron foundry, which comes next in order of position, are three cupolas, capable of running altogether, at one heat, 50 tons of metal; six drying stoves, and two air furnaces, used principally for large brass castings, such as the stem and stern posts of the armour-clad frigates recently constructed at Jarrow, the Swiftsure and the Triumph, in each of which vessels the stern posts of brass weighed 30 tons. Behind the foundry is the pattern making shop, with stores for wood, &c. The brass foundry contains eight furnaces, each large enough to take a 300 lb. pot, so that a little over a ton of metal might be run from them at once. In this foundry there is also a drying stove. The smithy consists of 24 smiths' fires, and a small steam hammer placed amongst them; there are also four furnaces for melting down scrap, two heating furnaces for heavy forgings, and three steam hammers, the heaviest of which weighs 7 tons. Next come the fitting and turning shops, which contain an assortment of excellent tools, and adjoining this is the drilling and plate-bending shed, where there is an hydraulic press capable of bending iron cold up to 9 in. in thickness. Then come the offices, and beyond them again a shed containing other drilling, bending, and shearing machines, situated just opposite to the building slips, and beyond this again the stores for tools, &c. This brings us up to the further extremity of the company's premises. The range of shops, &c., through which we have now passed approach the river bank at either end, but in the middle of the premises there is a considerable breadth of land between them and the river, which has been amply utilised, and we must, therefore, take our reader back a great portion of the way over which we have now travelled, to describe the manner in which the foreshore is utilised where the breadth of land is greater. Nearly in front of the brass foundry is a rivet making shop, at one end of which is a store for round iron. In this shop are two of Brown's rivet making machines, each accompanied by a stove for heating the bars. In front of this again, and reaching down to the river side is the boiler making shop, alongside of which is a quay with large plate-iron sheer-legs for shipping boilers. These legs are 90 ft. high, and have been tested to 112 tons. They are on the same pattern as the sheer-legs at Southampton docks, and are worked by a small horizontal direct-acting steam engine fed by a vertical boiler. Beyond this again is a dry dock, 410 ft. long, closed by a plate iron caisson, and still further on is room for the erection of some eight or ten vessels side by side. At the time of our visit one vessel had just been launched, and there were still on hand six others, some of very large size, including the double turret armour-plated war ship Gorgon, the thickness of whose armour is 8½ in., since successfully launched. At the further extremity of the yard is a patent slip.

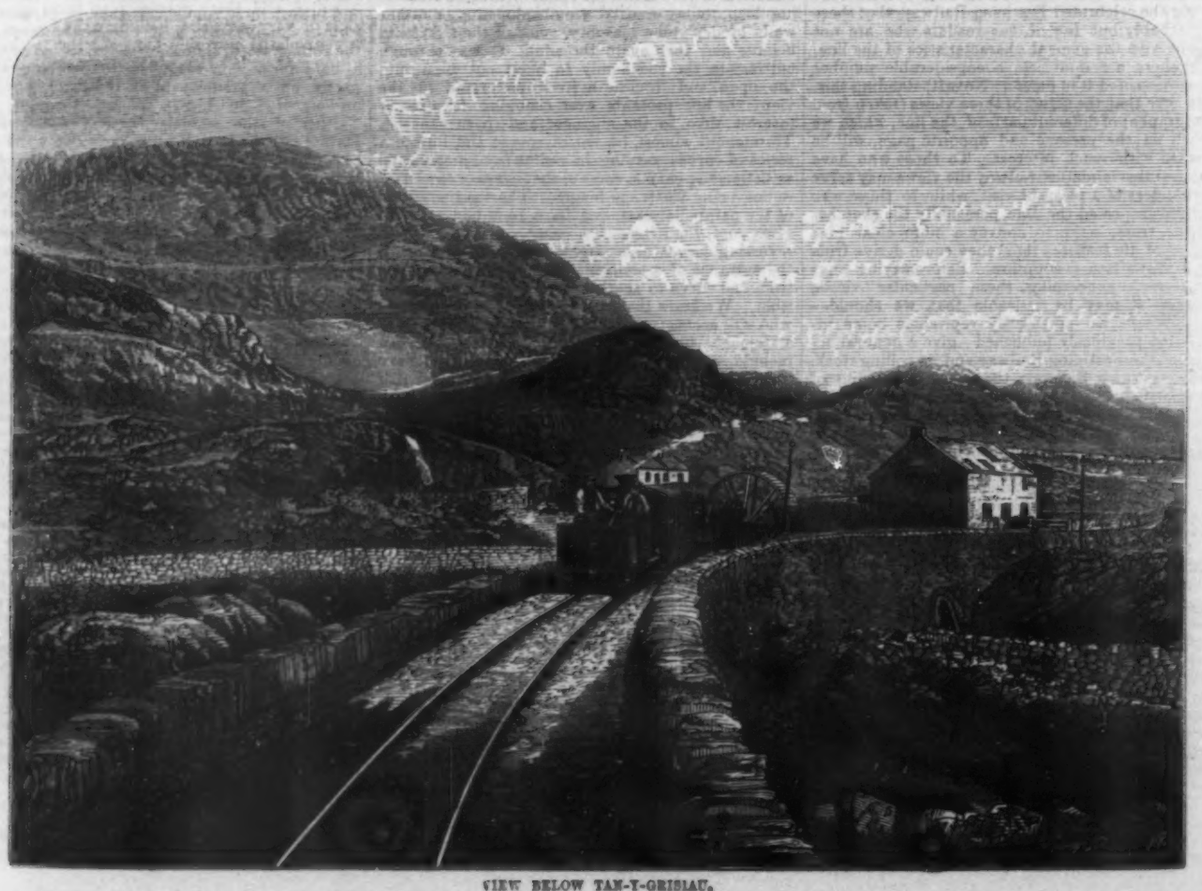
Besides the works at Jarrow, Palmer's Shipbuilding and Iron Company have, at Howdon, opposite, another shipbuilding yard, at present employed in the construction of wrought ironwork for bridges, &c. This yard is at present principally occupied with the ironwork necessary to substitute wrought-iron arches for the old wooden arches, a work of much difficulty, considering the constant traffic. This company have also blast furnaces at Wallsend, at present out of blast.

AUDEMAR'S EXPANSION GEAR.—On the 8th page of our tenth volume we published a drawing and description of a simple and efficient expansion gear for winding engines invented by M. H. Audemar, engineer to the Blanzy mines, (Saone-et-Loire). The invention consists in the addition of a double beat expansion valve, actuated through a bell crank lever by a cam, and placed in the steam at the point where the latter joins the valve chest. The cam, which is of a peculiar form, is carried on a vertical shaft, driven by gearing from the main shaft, and can be raised or lowered so as to bring one or other of its bearers in contact with the bell crank lever before mentioned. When the cam is in its normal position, the cut-off depends upon the ordinary slide valve. But when it is shifted so that it comes in contact with the lever at other parts of its surface, the equilibrium valve effects the cut-off, which is earlier or later according to the relative position of the cam. The apparatus is under the control of an attendant, who regulates it by a hand-wheel, and who can throw it out of gear when desired. This expansion gear has already found an extensive adoption in France, where ten winding engines having collectively 2780 horse power in the Saone-et-Loire are fitted with it, and in the Mines du Nord de Charleroy in Belgium it is also applied. Messrs. John Cockerill of Seraing have also adopted it. Mr. Charles Ball, of 21, New Bridge-street, E. C., who is M. Audemar's representative, proposes to accompany a party of English engineers next month to the Blanzy mines, in order that they may have every opportunity of judging for themselves of the value of the invention.

THE FESTINIOG RAILWAY.

MR. C. E. SPOONER, ENGINEER.

DESCENDING TRAIN WITH PASSENGERS, QUARRYMEN AND WORKMEN, DRAWN BY THE FAIRLIE ENGINE, "LITTLE WONDER."



VIEW BELOW TAN-Y-GRISIAU.

THE FESTINIOG RAILWAY.

MR. C. E. SPOONER, ENGINEER.

ASCENDING TRAIN DRAWN BY THE FAIRLIE LOCOMOTIVE "LITTLE WONDER."

So much has at different times been written concerning the celebrated Festiniog Railway, that there are probably but few of our readers who are not familiar with the general characteristics of the line, while there are doubtless a considerable number who have visited it in person. Notwithstanding this, we believe that the series of three views (taken from photographs) of different parts of the line, which we publish on the present and opposite page, will be regarded with much interest. To those who have examined this miniature railway the views may serve as reminders of a pleasant visit, while to those who have not inspected the line personally the sketches will, we trust, serve to convey a more clear idea of some of its features than they could derive from any mere written description. Before saying anything more concerning these particular views, however, it may be desirable that we should—even though we necessarily reproduce some information previously published—give a general account of the Festiniog Railway and its rolling stock.

The Festiniog Railway, then, is a single line of 1 ft. 11½ in. gauge, extending from the shipping port of Portmadoc to some slate quarries at Dinas, in the neighbourhood of Festiniog. Its length is 13¼ miles, exclusive of a branch, about a mile long, leading to Duffws. In the 13¼ miles the main line rises 700 ft., the rising gradients being continuous, but variable. For the first mile, indeed, from Portmadoc the line rises very slightly, the portion on the Traethmawr embankment, which extends across the mouth of the river at Portmadoc, being practically level, as the inclination is but 1 in 1343½. Exclusive of this flat portion of the line, the least gradient is 1 in 186, while the steepest is 1 in 68.69. The steepest gradient of any great length, however, is one of 79.82, which extends for about 2½ miles, while there is another of about the same length, of 1 in 85.22, and one, about 2 miles long, of 1 in 82.71. For a length of 12½ miles the average gradient is 1 in 92.

Traversing a rugged but most picturesque tract of country, now creeping along the steep hillside hundreds of feet above the valley below, now crossing deep ravines on narrow embankments, or rather walls of dry stone masonry, some of them 60 ft. in height, and then again threading its way through cuttings in the rock, only to burst out anew into the open and disclose a fresh panorama to the view, the line presents ever changing features of interest alike to the engineer and to the tourist. Throughout almost its entire course the line is a series of curves varying in radius from 8 chains to as little as 1½ chains, some of the curves of the latter radius being 200 ft. in length. The curves are all of the parabolic class, and have been laid out with great care, the extremities being eased off into the reversing curves or straight lines, and as a result the entrance of a train into a curve or its passage from one curve to another is practically imperceptible. We know that there are some of our readers who will accuse us of exaggeration in making this statement; but we are certain that they will not include amongst their number any who have visited the Festiniog line itself. We must own that before we travelled over the line personally we ourselves regarded with a certain small amount of incredulity the accounts which reached us of the extraordinary ease and steadiness with which the curves were traversed on the Festiniog Railway; but having experienced that ease it is only fair that we should atone for our early want of faith by adding our testimony to that of others. The result is, no doubt, due primarily to the adoption of the parabolic form for the curves; but its attainment also in no slight measure depends upon the admirable condition in which the permanent way is maintained—a condition of which we shall have something more to say presently—as well as upon the narrowness of the gauge and the short wheel base of the rolling stock.

The width of the line on embankments is 10 ft. at formation level; but in many of the cuttings there is a width of but 8 ft., and the clearance between the rock and the sides of the engines is excessively small. In the tunnels—of which there are two on the line, one 60 yards and the other 730 yards in length—it is, if possible, still closer work, and in fact these tunnels, as they at present stand, form a complete bar to any further enlargement of the rolling stock. The shorter tunnel passes through a slate formation, while the longer one, which is partly on a gradient of 1 in 85.22, and partly on one of 1 in 116.59, is cut through syenite. Neither of the tunnels is lined. A prominent feature on the line are the dry stone walls or embankments to which we have already referred. The view on page 418, taken in the neighbourhood of Tan-y-Grisiau station, shows a train passing over one of these walls, although it scarcely gives a fair idea of the narrowness nor height of the latter. The view to which we have referred is taken at a point where the line formerly followed the contour of the hillside, making a deep bend, as shown on the left of the sketch. By the construction of the embankment, however, this detour is now avoided, the line being carried directly across the ravine. In some cases the embankments or "breast walls," as they are locally called, instead of being constructed of dry stone masonry throughout, are formed of a pair of retaining walls filled in between with soil. The side batter is usually about 1 in 5. The culverts are of dry masonry, faced in mortar, and with the exception of one iron girder bridge, which crosses a turnpike road, the under bridges are all of stone masonry.

We have already referred briefly to the permanent way, and we must now enter into further details. In 1832, when the construction of the Festiniog Railway was commenced, it was intended that the line should merely be a tramway, on which the trains of loaded slate wagons should descend by gravity, while the empty trucks, or trucks loaded with coals or sundries, were hauled back by horses. This state of affairs continued until 1863, when, on the recommendation of Mr. C. E. Spooner, the engineer of the line, locomotive power was adopted. During the autumn of 1864 passengers were carried by the company experimentally, without charge, and in the following year the line was regularly opened for

passenger traffic. These changes have, of course, necessitated a corresponding change in the permanent way. The rails originally used weighed but 16 lb. per yard, and these were subsequently replaced by others weighing 30 lb. per yard, most of which were laid more than 18 years ago. These 30 lb. rails have, however, in their turn been found too light, and the line is now relaid for the greater part of its length with double-headed rails weighing 48.66 lb. per yard. These rails are fixed by strong chairs to 9 in. by 4½ in. larch cross sleepers, 4 ft. 6 in. long, and placed 3 ft. apart from centre to centre, except at the joints, where the pitch is contracted to 2 ft. At each joint a frame is formed by placing two sleepers as longitudinals under the cross sleepers, and spiking the latter to them. This arrangement, combined with the use of a very stiff form of fish-plate* made to embrace the bottom flange of the rails, enables the joints to be rendered very firm and even, an important matter in a narrow gauge line worked at what are relatively very high speeds. Of the care taken in laying out the curves we have already spoken, and we need merely add, therefore, that in bending the rails accurate work is secured by employing the extremely handy little portable rail-bending machine, designed by Mr. Spooner, and illustrated and described by us on page 263 of our eighth volume. A matter to which Mr. Spooner has paid especial attention—and a most important matter it is—is the drainage of the line, and as a result he has obtained one of the best, if not, indeed, *the* very best, pieces of permanent way which we ever inspected. In the course of last autumn we had the opportunity of examining carefully long lengths in different parts of the Festiniog Railway, and we were especially struck by the entire absence of even the slightest sign of subsidence in the ballast, or the least crack indicating a movement in the sleepers. In fact, we may say at once that we never saw a piece of line of any length with the ballast in an equally perfect condition.

We have directed particular attention to the state of the permanent way on the Festiniog Railway because it is important that it should be borne in mind in considering the capabilities of narrow gauge lines. In writing of this subject more than twelve months ago (*vide* page 335 of our tenth volume) we said: "The narrower the gauge the greater is the angle through which a vehicle is canted laterally through a certain elevation or depression of one of the rails, and the greater, therefore, is the inequality produced in the loads on the springs on opposite sides, and consequently on the two rails also. In fact the narrower the gauge the greater the amount of lateral oscillation to which any given inequality in the line will give rise, and this is a point of special importance in districts where, from the variations of climate or other influences, the permanent way is liable at times to get more or less out of repair." A consideration of the matters to which we thus directed attention will show the vast importance of maintaining a narrow gauge line in good condition, if it is to be employed for carrying anything like fast traffic. Under the charge of an engineer of energy and capability like Mr. Spooner, having not only the will but the power to maintain his line in practically perfect order, a road of very narrow gauge may, without even incurring risk, be employed to accommodate traffic which it would be simply reckless to run upon a line of the same gauge less thoroughly well constructed and less efficiently maintained. We, therefore, by no means desire it to be inferred that because the Festiniog Railway has for some time very successfully accommodated a relatively fast passenger traffic, and because passenger trains drawn by the Fairlie engine "Little Wonder," have frequently traversed portions of it at speeds of over 30 miles per hour, that, therefore, similar feats could be safely performed on all lines of 1 ft. 11½ in. gauge. On the Festiniog line, thanks to the perfect condition of its permanent way, the trains run, even at the speeds last mentioned, as steadily as on the best piece of 4 ft. 8½ in. gauge line we ever rode upon, and with an entire absence of any shock or jar on entering and leaving curves; but in narrow gauge lines worked under less favourable circumstances an equally satisfactory result can scarcely be expected, and it is, therefore, desirable that on almost all such lines the gauge adopted, if fast trains are to be run, should materially exceed that of the Festiniog Railway if only to allow for less perfect maintenance.

There are besides the termini four intermediate stations on the Festiniog Railway, namely, Minffordd Junction (the next station to Portmadoc, where there is the transshipment station, recently referred to by us in our review of Mr. Spooner's book, for interchange of traffic with the Cambrian Railway), Penrhyn, Hafod-Llyn, and Tan-y-Grisian. These stations have no platforms (the lowness of the carriages rendering this unnecessary), but they are provided with all necessary accommodation, although on a small scale. The engine sheds and the principal constructing and repairing shops are about a mile from Portmadoc, although there is also a carriage shed close to the latter station. Everything at these workshops and running sheds is of course in miniature; but it is none the less complete. It is, we believe, only by actually seeing and examining such workshops and sheds as these that the economy attendant upon the maintenance of narrow gauge stock can be thoroughly understood. A railway engineer visiting such shops cannot but be struck by the facilities for repairs which such miniature rolling stock affords. The small parts to be dealt with, the comparatively trifling weights to be lifted, and consequently the simple lifting tackle required, the small wheel lathes and other tools necessary, and many other matters of a similar kind, all have to be seen and examined into personally before they are appreciated at their full value.

The line is worked on the "staff" system, assisted by telegraph. All the stations and signal boxes are in telegraph communication with each other, and the signalling arrangements, &c., are as complete as on ordinary lines of the 4 ft. 8½ in. gauge. The same remark also applies to the systems of points and crossings, turntable, and other fixed plant required for accommodating the traffic.

We have now to speak of the rolling stock, and we shall commence with the engines. The two locomotives originally built for the line by Messrs. G. England and Co. in 1863, are four-wheeled engines, the wheels being 2 ft. in diameter and coupled. The wheel base is 5 ft. and the cylinders, which are outside, are 8 in. in diameter with 12 in. stroke. The weight of these engines in working order is 8 tons. Subsequently Messrs. England built five other engines* of a similar class, two of them, however, being heavier and weighing 10 tons in working order. One of the 10-ton engines will take up in ordinary work a train consisting of itself and tender, one first-class, one second-class, and one third-class carriage, a guard's brake-van, four goods wagons, and twenty-four slate wagons, these last being empty. The total gross weight of such a train inclusive of engine and tender will be 55 tons, of which about 16 tons consist of passengers and goods carried. During the down journey, the goods wagons being then empty and the slate wagons loaded, the total weight of the train will be about 93 tons, of which 54 tons is paying load carried.

The year 1869 was marked by the introduction of the Fairlie engine on the Festiniog Railway, and the results which have since been obtained show that Mr. Spooner exercised sound judgment in recommending the adoption of this system. The Fairlie engine, "Little Wonder," placed on the line in 1869, was built at the Hatcham Iron Works, and an illustration and a full description of it appeared in our columns early last year (*vide* page 316 of our ninth volume). We may, however, repeat here that the engine is mounted on two steam bogies, each bogie having four coupled wheels 2 ft. 4 in. in diameter. The wheel base of each bogie is 5 ft., and the total wheel base of the engine 19 ft., while the weight in working order is 19½ tons. Each bogie has a pair of cylinders 8½ in. in diameter, with 13 in. stroke. In ordinary work this engine will take up a train consisting of three carriages (first, second, and third class), a guard's brake-van, six goods wagons, and one hundred and twelve empty slate wagons, the total gross weight, inclusive of engine, being 127½ tons, of which about 21 tons will be passengers and goods carried. On the down journey, when the slate trucks are loaded and the goods wagons empty, the total weight of engine and train is about 336½ tons, of which 230 tons are paying load. During the visit of the Russian Imperial Commission to the Festiniog Railway in February, 1870, the "Little Wonder" took still greater loads, but as full accounts of these performances were published in our pages at the time,* we need merely refer to them here.

Such a train as that we have just mentioned, as forming an ordinary load for the "Little Wonder," measures over 1200 ft. in length, and on some parts of the line it is thus on three or more curves at once, the different parts of the train being moving towards almost all points of the compass. Riding in one of the last wagons of such a train it is at times difficult for a stranger to realise that the engine which he sees moving along the opposite side of a ravine in a direction almost exactly opposed to that in which he is travelling, can possibly have any connexion with the vehicle in which he is carried. The engravings on pages 418 and 419, prepared from photographs, will give some—although we fear but a faint—idea of the appearance of these long trains. The first of these views shows a descending train, loaded with passengers, quarrymen, and workmen, passing round one of the 1¾ chain curves, only the engine and six carriages, and about four-and-twenty of the wagons being, however, visible. The other view, on page 419, shows an ascending train of goods wagons, passenger carriages, and empty slate wagons, the front part of the train standing on one of the breast walls already referred to, while further back it extends round one of the 1¾ chain curves. Here again but a portion of the train is visible, the hinder part extending through the bridge shown on the left in the background of the illustration. The line, in fact, forms such a succession of curves that it is almost impossible to obtain a point of view from which one of these long trains can be seen clearly throughout its length.

It is not, however, for its hauling power alone that the Fairlie locomotive, "Little Wonder," is distinguished. An equally important matter is the ease and steadiness with which it traverses the sharpest curves on the line. We have repeatedly directed attention to this point; but we may nevertheless again speak of the matter here. We have ridden on the buffer beam of one of the bogies of the "Little Wonder" at speeds up to thirty-five miles per hour, and we can testify to the extraordinary steadiness of the running, both on the straight and curved portions of the line. On the footplate—which is supported by the carrier frame connecting the two bogies—the ease of the motion is still more remarkable; and the expression which has been frequently made use of, that the engine "appears to glide round the curves," is really the only one giving a fair idea of the movement. As regards the economy of fuel, also, the "Little Wonder" has given most satisfactory results, Mr. Spooner stating that her consumption in proportion to the work done is quite 25 per cent. below that of the other engines on the line.

The present article has already become so lengthy that we must make our remarks concerning the rolling stock of the Festiniog Railway as brief as possible. The passenger carriages in use on the line are of various types. Those most recently built may be regarded as ordinary railway carriages in miniature; but in others the seats are placed longitudinally, the passengers sitting in two rows back to back. In some of these latter carriages there are no sides, the passengers being, however, protected by strong leather aprons which reach about half way up the sides of the carriages and are secured to the ends and intermediate pillars by straps. The carriages with longitudinal seats are 10 ft. long by 6 ft. 3 in. wide, (outside dimensions) while they weigh 26 cwt., and carry twelve first-class or fourteen second or third-class passengers. The carriages most recently built are 9 ft. 9 in. long by 4 ft. 10½ in. wide outside, or 9 ft. 2 in. long by 4 ft. 6 in. wide, inside dimensions; and each is divided into two compartments by a partition reaching about half the height of the carriage. The seats run transversely as usual, each seat accommodating three persons, so that each carriage carries twelve passengers. The height is somewhat small, being only 4 ft. 9 in. inside at the centre. The wheel base is 5 ft. 6 in., and the diameter of the wheels both for these and the other carriages and wagons is 1 ft. 6 in. The wheels are of cast iron with wrought-iron tyres, and the carriages are mounted on springs of the ordinary form. The carriages are well lighted by side windows and a lamp is provided in the roof. The weight of these carriages is but 23 cwt. or less than 2 cwt. per passenger carried.

* This arrangement of fish-joint has been patented by Mr. Spooner and Mr. Huddart, and various modifications of it were illustrated and described by us on page 248 of our eighth volume.

* These engines were illustrated and fully described by us on page 316 of our third volume.

* *Vide* page 121 of our ninth volume.

The goods wagons are of a number of different patterns, some of them being shown in the view on page 419. The slate trucks are platform wagons with open sides of angle iron, and are of two principal classes, the large carrying 3 tons, and the small carrying 2 tons of slates. A large number of them are provided with simple brakes, it being usual to run the trains with a brake on every fifth truck. The weights, &c., of some of the principal varieties of goods stock are given by Mr. Spooner as follows:

Class of Vehicle.	Wheel base.	Weight empty.	Load carried.
	ft. in.	cwt.	tons
Coal trucks	5 6	19	3
Goods „	5 6	18	2½
Bogie timber trucks	3 0	per 26 pair	9
Slate wagons (small)	5 2 11½ / 3 1½	13	2
„ „ (large)	5 6	19	3
„ „ with brake	5 6	21	3

The loads above given for the slate wagons are those carried when fully loaded with large sized slates. From an inspection, a short time ago, of the books of the company recording the gross weight of, and net load carried by, each train, we found that the proportion of paying load to dead weight varied, in the case of the slate trains, from a little more than 2 to 1 to 5 to 1, the general average being over 2½ to 1—an excellent result. The slate wagons, we should mention, are not mounted on springs.

The whole of the rolling stock is provided with central buffers and couplings, an arrangement which of course materially facilitates the passage of the curves. The speed was at first limited by the Board of Trade regulations to twelve miles per hour, but more recently these restrictions have, we believe, been entirely removed, and we have in fact travelled over long lengths of the line on the "Little Wonder" at nearly three times that speed, without, as we have already stated, experiencing the least unsteadiness. Of course, however, such a speed as this would not be safe with the four-wheeled engines.

In conclusion, it is desirable that we give some particulars of the traffic which the Festiniog line is accommodating. We have not the figures for the last year by us, but during 1869, the passengers carried amounted to 97,000, and the goods and mineral traffic to 18,660 tons, and 115,132 tons respectively. The train mileage was 45,619 miles, and the total engine mileage 50,314 miles. The total receipts for the year were 23,676*l.* 12s. 10d., while the cost of working, repairs, and maintenance was 10,518*l.* 6s. 3d., and the special expenditure 2535*l.* 11s. 7d., making the total expenditure 13,053*l.* 17s. 10d. The line thus yielded during the year a net revenue of 10,622*l.* 15s., equal to a dividend at the rate of 29½ per cent. on the original capital of 36,185*l.* 10s., or at the rate of 13½ per cent. on the present capital of 86,135s. 10d. The 50,000*l.* forming the difference between the present and original capital has, we should state, been accumulated out of revenue. Notwithstanding the large amount of traffic it has accomodated it must be borne in mind that the Festiniog Railway is very far from being worked up to its full capacity. There is no night traffic on it and no Sunday trains, and even by using Fairlie engines alone in place of the six four-wheeled locomotives at present on the line nearly double the traffic could be carried.

We have, we think, said sufficient to show that the Festiniog Railway is a line possessing a vast amount of interest for engineers at the present time when narrow gauge railways are steadily and surely making their way. It is, in fact, the most perfect miniature railway in existence, and it is deserving of being most carefully studied in all its details. We notice that amongst the schemes before Parliament this session is an extension of the Festiniog line on the same gauge to Bettws-y-Coed, the favourite resort of artists. The energy and engineering skill shown by Mr. C. E. Spooner in bringing the Festiniog line to its present admirable state form a sufficient guarantee that if this undertaking receives Parliamentary sanction—as it undoubtedly should do—it will be carried out in a thoroughly satisfactory manner; and from what we know of the district we feel certain that the line is one which would not only be advantageous to the local proprietors, but would also be highly appreciated by the thousands of tourists who annually flock to the beautiful district which it is proposed to traverse.

NOTES FROM PARIS.

PARIS, Dec. 26, 1871.

BLASTING THE MEUSE.

THE Eastern of France Railway Company constructed over the Meuse, at Charleville, a temporary timber viaduct to replace the stone bridge destroyed by the necessities of the war. The recent cold having frozen the river, much apprehension arose for the safety of the piers, when the thaw should arrive, as they were unprotected by ice guards. The use of dynamite was suggested, and thanks to the employment of this explosive, all danger was avoided. The mode of conducting the somewhat interesting and decidedly novel work was as follows: The river which was frozen between the bridge of Charleville and that of Mézières for a length of about 1400 yards, was besides impeded with an accumulation of piled-up ice. Holes were broken with a hatchet and through them were introduced charges of dynamite of one or two cartridges of 1150 grains, each fitted with a cap heavily charged with fulminate of mercury, and a fuse. The charge suspended from a thread was sunk to a depth of about 3 ft. in the water. The explosion generally produced blocks of ice sufficiently small to pass through the openings of the bridge without inconvenience. Such blocks as were too large were afterwards again attacked in a similar manner, and subdivided. The operation lasted three days, and about 55 lb. of dynamite were sufficient completely to clear the river and relieve the viaduct.

IMPORTATION OF IRON IN 1870.

The bulletin of the *Comité des Forges de France*, the publication of which was stopped in August, 1870, has just reappeared, and contains the statistics of iron ore, and cast and wrought iron, introduced into France during 1869 and 1870. The following figures give an abstract of these statistics of total importations:

Ores.		Cast iron.		Bars and plates.	
1870.	1869.	1870.	1869.	1870.	1869.
485,005	592,179	113,235	139,113	66,746	76,176

It is easy to judge from these figures of the disastrous effects of the war, since these lamentable results of the whole year are due to the trouble brought by the war in the space of only six months, and on a portion of the country.

THE EXPEDITION TO VIGO.

The journals are beginning again to call public attention to this singular enterprise, of which already as much has been said. The articles which are published appear to be inspired by the promoter of the affair, and give details of the preparation for the departure of the expedition.

The ship Vigo is a three-masted vessel of 1500 tons, with a crew of 60 men, and 15 divers. On board are placed various portable engines, provided with appliances for driving the pumps and working the magneto-electric machines for producing the light necessary for making the investigation. There are, of course, sounding apparatus, rubber tubing for extracting mud and sand, and two 6-ton cranes, the one carrying a powerful submarine lamp, the other a submarine observatory, formed of a cylindrical chamber of plate iron, large enough for two men, and fitted with two thick glass windows.

The material includes dredging machines, intended for clearing the mud, and having the form of a harrow with wrought-iron teeth, furnished with an air chamber to give it buoyancy. The Vigo is also furnished with a supply of the necessary tools for the repair of the materials.

M. Bazin, the engineer, proposes to conduct operations in the following manner. A dredging machine will be first lowered to determine the position of a wreck. By help of the observatory and the electric lamp, he will obtain the necessary information. He will then clear away the mud, empty the interior of the wreck by the help of water under pressure. Lastly, he will lift it with cranes, after having broken it, if necessary, by the aid of torpedoes.

In this programme there has certainly been a great display of ingenuity, and the well-known fertility of the inventor who undertakes the work inspires some hope that the many difficulties to be encountered will be overcome, but it is impossible to judge at present of the chances of success to an enterprise at once so bold and novel.

RESISTANCE TO FLEXURE BEYOND THE ELASTIC LIMITS.

M. Tresca, sub-director of the Conservatoire des Arts et Métiers, has contributed to the Academy of Sciences the result of some experiments which he has undertaken on the subject of the resistance to flexure beyond the limits of elasticity.

The trials were made on iron and steel rails, supported at both ends, and exposed in the middle to the action of a powerful hydraulic press. The strains were registered on a gauge, and the flexures were recorded by a cathetometer, which indicated the differences near to each support, and a third in the middle of the rail. M. Tresca guarantees the perfect correctness of the results which he presents tabulated, and with curves of deflection.

The trials supplied at first for the coefficient of elasticity of iron and steel—21,000,000,000. Writing on the subject, M. Tresca says: "The results which are obtained by these experiments confirm the law relating to the flexure of iron and steel, with reference to the neutral axis, for the period of elasticity, the direct proportion of deflection to loads, and their inverse ratio to the cube of the span. They show that for both metals the coefficient of elasticity is almost the same, as we have previously shown by special experiments made, in 1857, on Swedish irons, and steel made from these irons. But what especially distinguishes these trials, is that they show that the limit of elasticity extends itself in the same bar in proportion as it is submitted to more energetic stress, manifesting itself by increasing, permanent curves, and that by putting repeatedly in action the molecular elasticity, this limit can be extended almost up to the point of rupture, without the coefficient of elasticity having varied considerably. A successive reduction of the original coefficient is always observed, which may extend as far as one-tenth of the original value. Iron and steel as it leaves the workshop is in a condition of manifest instability which disappears in use; it becomes more homogeneous and more elastic, but at the same time a little more flexible.

POWER TRANSMISSION REGULATOR.

It would be often useful to interpose between the driving pulley of a machine and the shaft that carries it, an arrangement which should make the two parts rigidly connected, whilst the power transmitted should remain below a fixed limit, and which should make them independent when this limit should be exceeded. In cranes or elevating machinery, for example, workmen would be prevented from overloading the machine. The amount of work performed by a machine could always thus be reduced to its safe limits.

There have often been introduced maximum power regulators, but the complication or defects of these apparatus have prevented their introduction. The *Revue Industrielle* gives the description of a system recently patented by M. Mettenet, which appears to us at once simple and efficacious. This regulator is composed of a disc keyed on the shaft, and having a diameter rather less than that of the pulley, of a pulley mounted loose on the shaft, and of a spring apparatus serving to communicate motion from the disc to the pulley. The whole arrangement presents the appearance of a pulley with two cheeks, of which one is fixed and the other loose on the shaft. In the interior is placed the spring mechanism. It is composed essentially of a flat plate spring, of which the two extremities are secured to the driving disc. The middle of this spring is embraced by a stirrup, a rod from which traverses a bolt articulated to the disc. A regulating screw allows an initial tension to be given to the spring, corresponding to the limit of power desired. The bolt bearing in a recess in an inclined plane on the loose pulley drives it so long as the resistance does not exceed a certain limit. But when the resistance exceeds this limit, the rod bends the spring, escapes on the inclined plane, and the disc ceases to actuate the pulley. The apparatus of M. Mettenet appears to be cheap and simple, and there are many cases in which it could be applied with a good chance of success.

PUMPING ENGINES.

M. H. Audemar, the able mining engineer of Blanzy Saone-et-Loire, has recently set to work, at the Shaft St. Marie, a pumping engine he has designed, and which raises in one lift, from a depth of 1115 ft., a volume of 770 gallons per minute. The engine, of 250 horse power, is placed at a depth of 984 ft. from the surface, in a chamber excavated in the rock, and measuring 82 ft. in length, 26 ft. in breadth, and 23 ft. in height. There are two engines coupled on the same shaft with one fly-wheel. On the extension of the piston rods are placed the force pumps, consisting of four horizontal plungers, which send the water into a common air chamber. The engines are supplied with steam from boilers on the ground level. The steam pipe is 7½ in. in diameter, and the loss of pressure is but very small. Leaving the air chamber, the water is led up to the ground level by a conduit following the sides of the shaft, and which is supported by brackets built in the wall.

Elevating pumps in the lowest level of the shaft raise the water into subsiding reservoirs, where it leaves behind it the clay, mud, and gravel, that would prevent action of the force pumps. The valves are so arranged as to reduce to a minimum the seat area, so that there may be only a slight difference between the upper and lower pressure at the moment of lifting. These valves are in cast steel, and are made spherical at the point of contact with the seat. They are found to work without any shock, and operate noiselessly, although they make about 18 strokes a minute, a considerable speed for such a pump. The steady working of these pumps confirms the expectations they raised when first set to work, and M. Audemar has apparently solved with success, thanks to the bold means he has employed, a problem of which the difficulties are well known.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.—The nineteenth annual meeting of this institution will be held in the room of the City Terminus Hotel, Cannon-street, on Saturday, January 6, at 8 p.m. On this occasion the balance-sheet and auditor's report for the past year will be presented, and the election of a president and other officers for 1872 will take place. Mr. J. Newton will also, we believe, deliver an address on the completion of his twelfth year of office as president of the Association, and retirement from that post.

M'CARTER'S CONDENSER AT THE CITY SAW MILLS, LONDONDERRY.

FIG. 2.

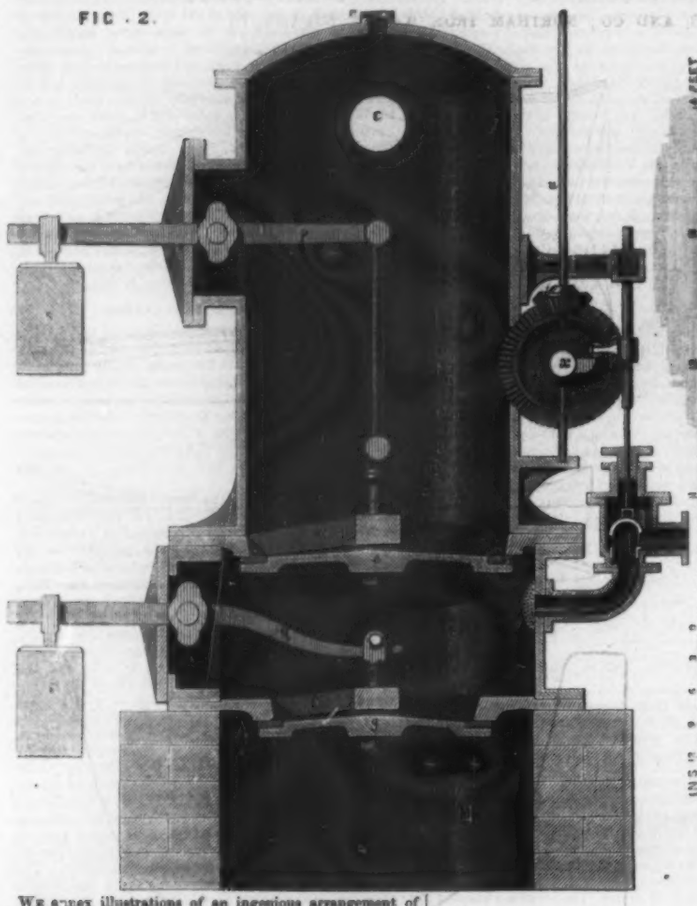


FIG. 1.

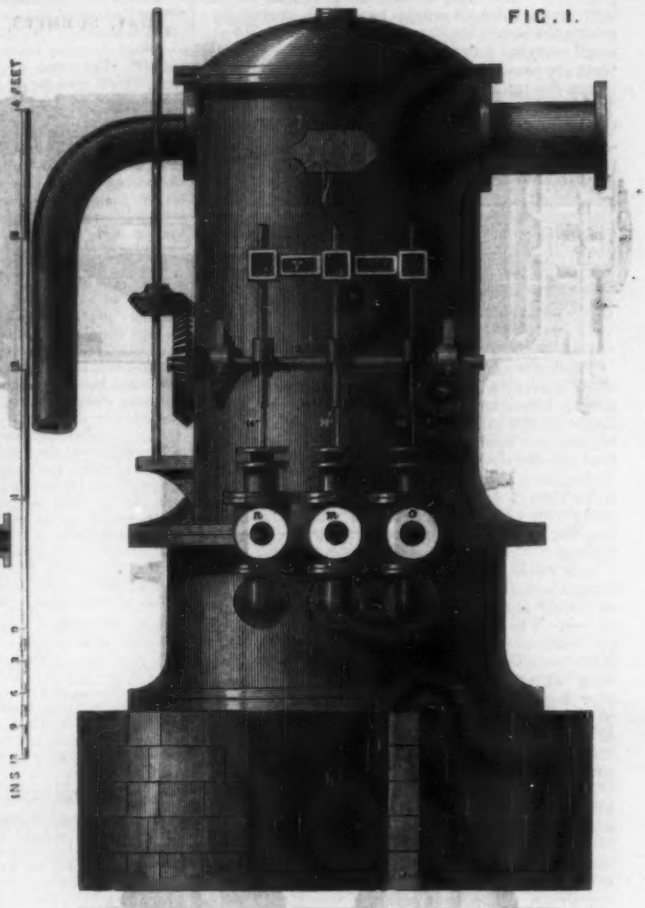
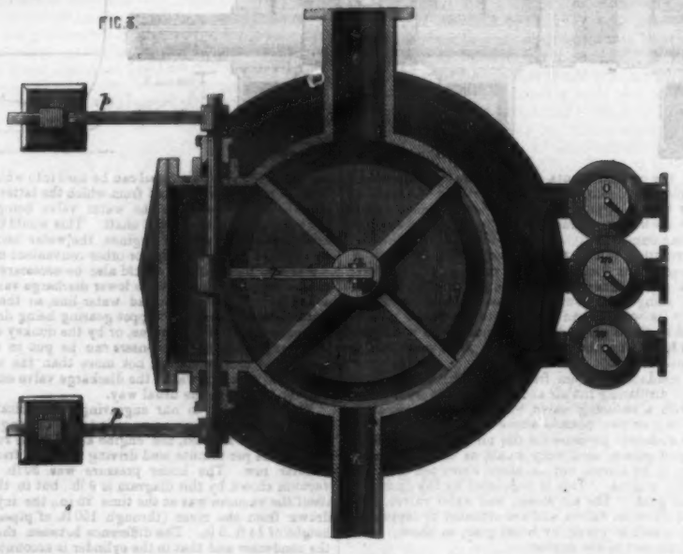
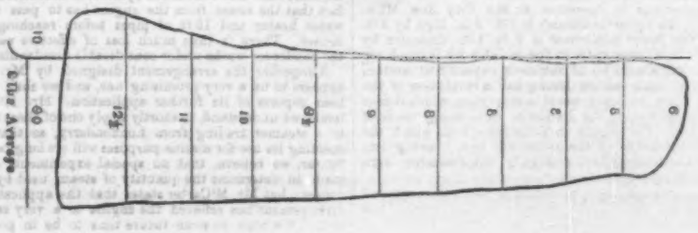


FIG. 3.





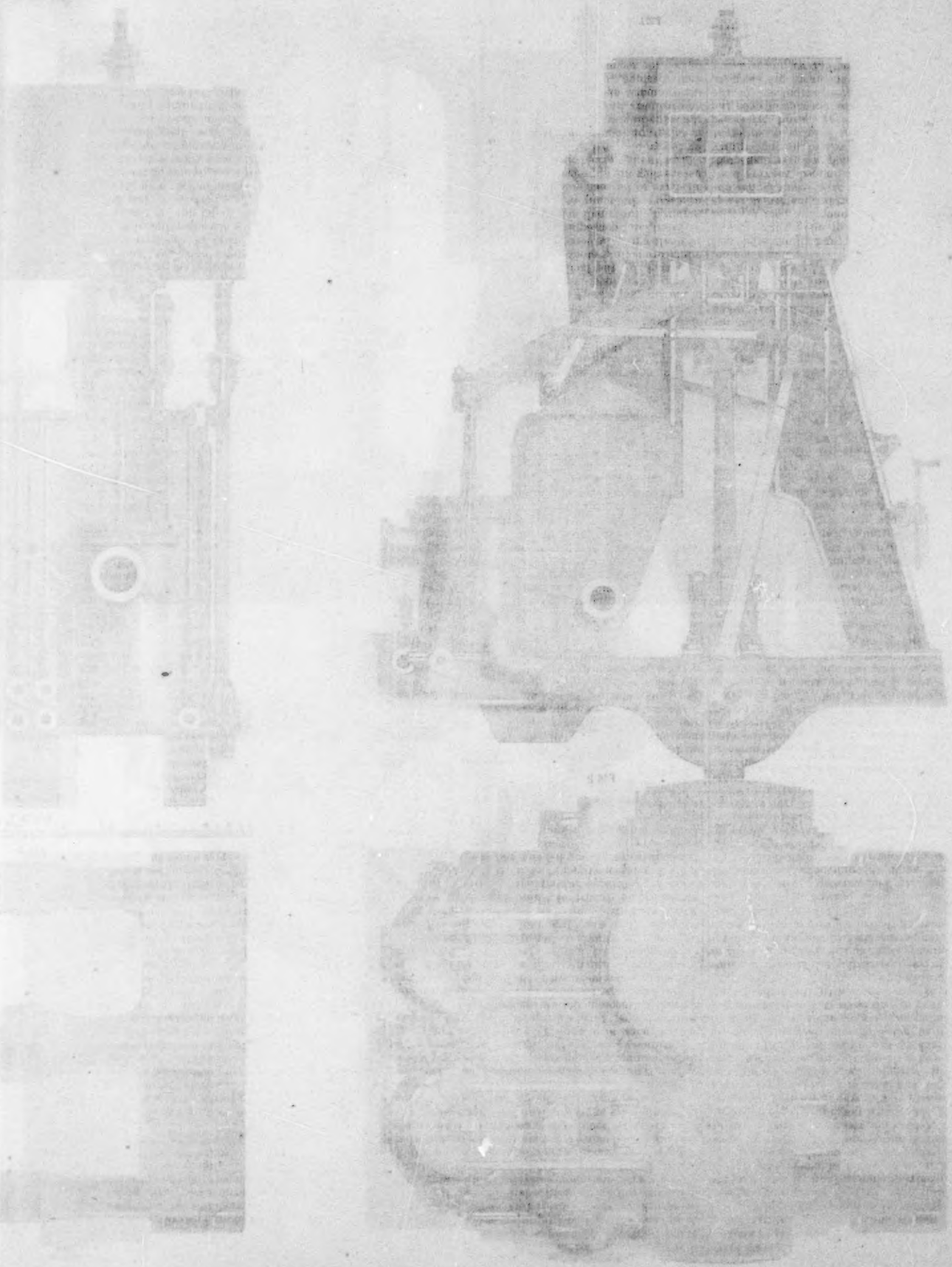
We annex illustrations of an ingenious arrangement of condenser designed by Mr. John W. M'Carter, of the City Saw Mills, Londonderry, and which has been in successful use for some months past on an engine at Mr. M'Carter's own works. This condenser differs from those of the ordinary blow-through type, in the fact that it is continuous in its action instead of intermittent, the vacuum gauge being found, we are informed by Mr. M'Carter, to stand as steady as if it was connected to a condenser fitted with an air pump. The arrangement also differs from a blow-through condenser in requiring no head of water to work it. The condenser at Mr. M'Carter's mill draws its supply of injection water from the river, the only thing which renders a head of water necessary being the small jet required for the lower chamber, as we shall explain presently. In land engines this jet may be supplied from a small cistern placed in any convenient position, while in the case of marine engines, the supply may be drawn from an air vessel fed by the feed or bilge pumps. We must, however, proceed to explain the construction and action of the condenser, referring for that purpose to our engravings.

The condenser is made in two compartments, termed the higher and lower. The exhaust steam pipe, *c*, from the engine communicates with the top of the higher compartment, *a*, this compartment having at the bottom an aperture, *d*, with a valve, *e*, opening into the lower compartment, *b*. This lower compartment has also at the bottom an aperture *e*, *f*, provided with a valve, *g*, opening into the waste water tank or discharge pipe, *h*.

The injection water enters by a rose nozzle projecting into the upper part of the higher compartment, and a snift valve, *r*, is provided on the top of the condenser for allowing any escape of air when blowing through before starting. The condenser valves, *e* and *g*, fitted to the bottom openings of the higher and lower compartments, are metal discs faced with india-rubber, and are kept in their places by spiral springs or counterbalances, *s*, acting upon the ends of levers, *p* and *q*, these levers being keyed on shafts passing through stuffing-boxes in the side of condenser.

Previous to starting the engine it is necessary to blow the air out of the upper vessel by passing steam through the engine in the usual way. The engine being started the condensation goes on in the ordinary manner, the injection water being brought from the river or tank by the vacuum formed in the upper compartment of the condenser. The vacuum is got up at first by a jet into it from a small cistern overhead, which is turned off after starting.

The engine having made a certain number of strokes a small quantity of steam from the boiler is admitted to the lower vessel through the steam valve, *o*, this steam displacing any air that may be left in that compartment. The water valve, *m*, being then opened, a small jet of water is



COMPOUND ENGINES FOR THE SC

CONSTRUCTED BY MESSRS. DAY, SUMMERS, A

(*For Descrip*

FIG.1.

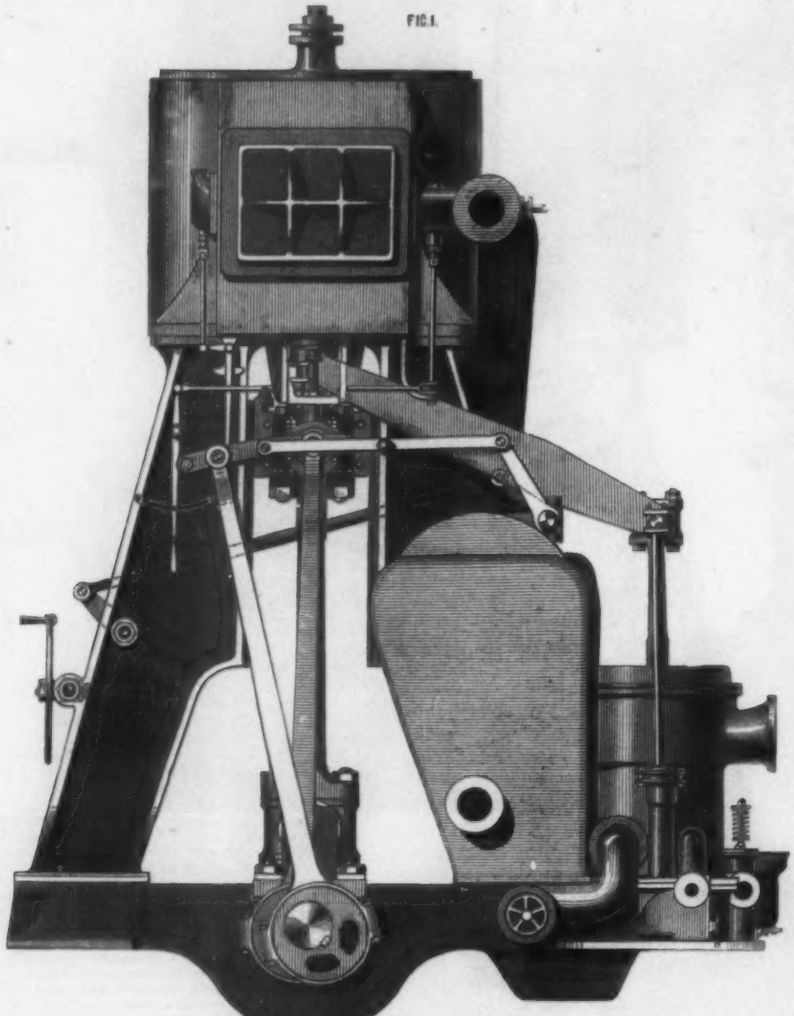
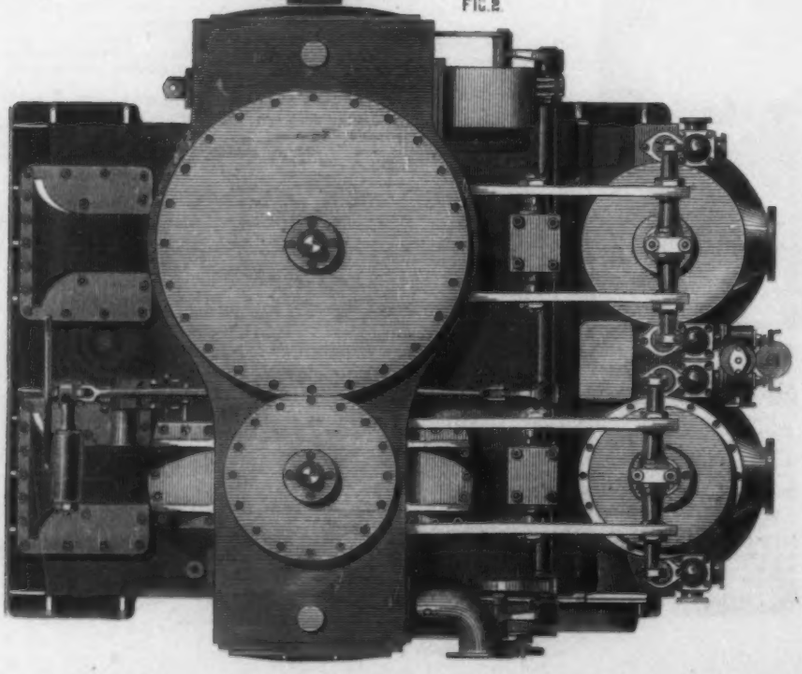
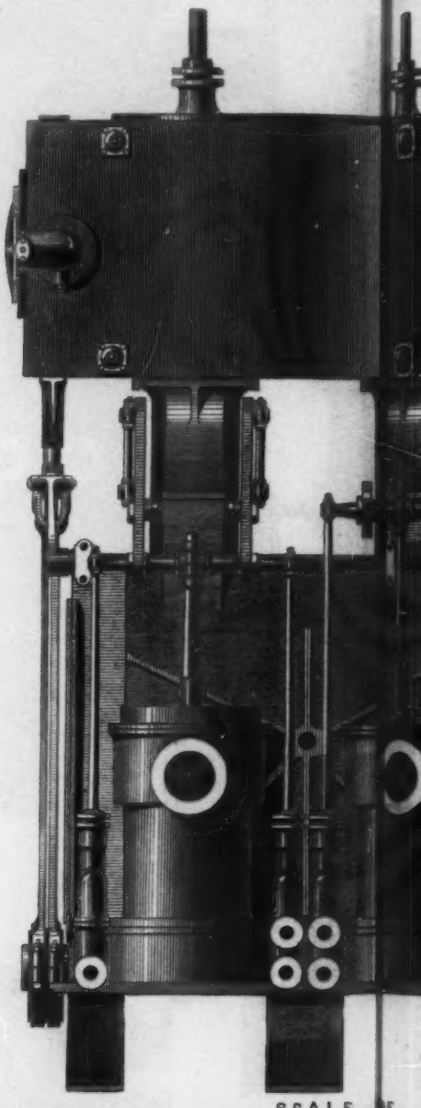


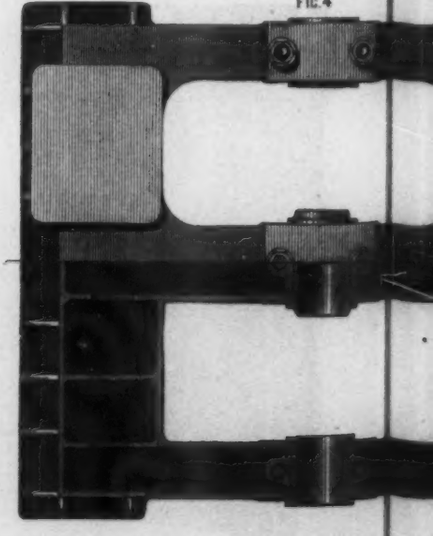
FIG.2.





SCALE

FIG.4



SCREW STEAMSHIP "SIR BEVIS."

ES, AND CO., ENGINEERS, SOUTHAMPTON.

(*...ue Page 423.*)

FIG. 5.

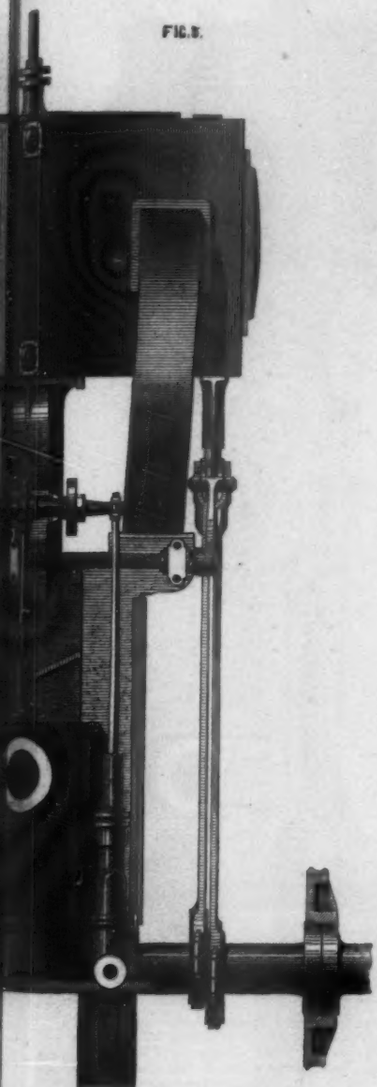


FIG. 5.

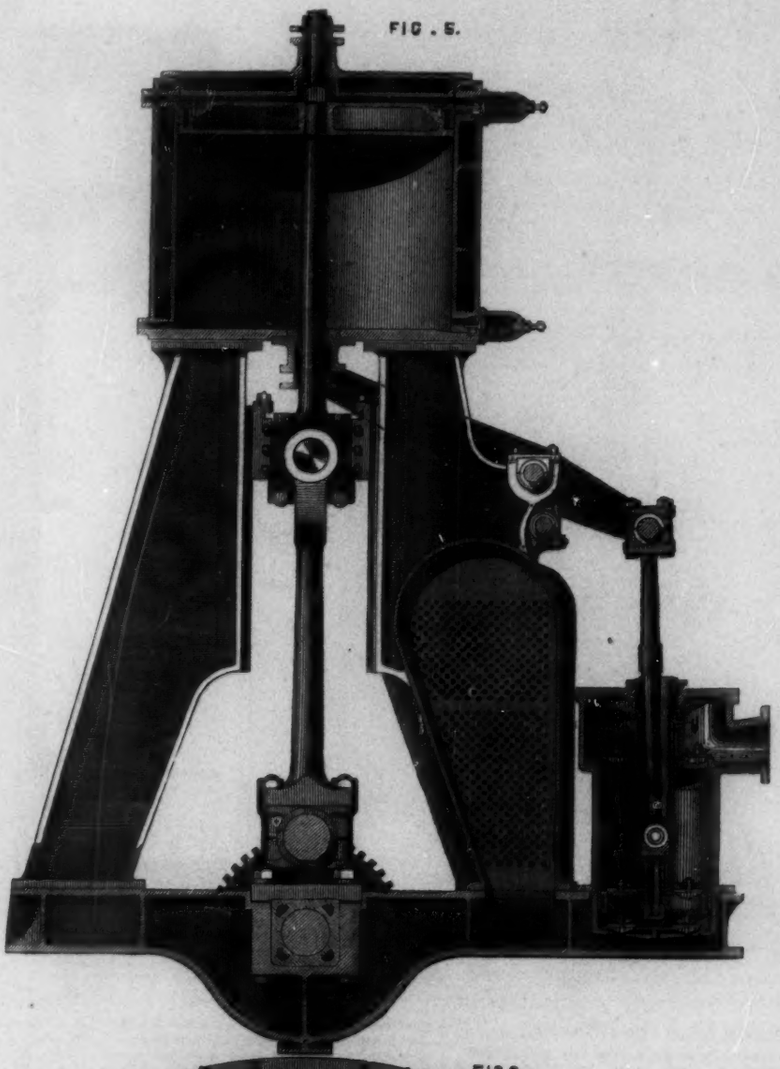
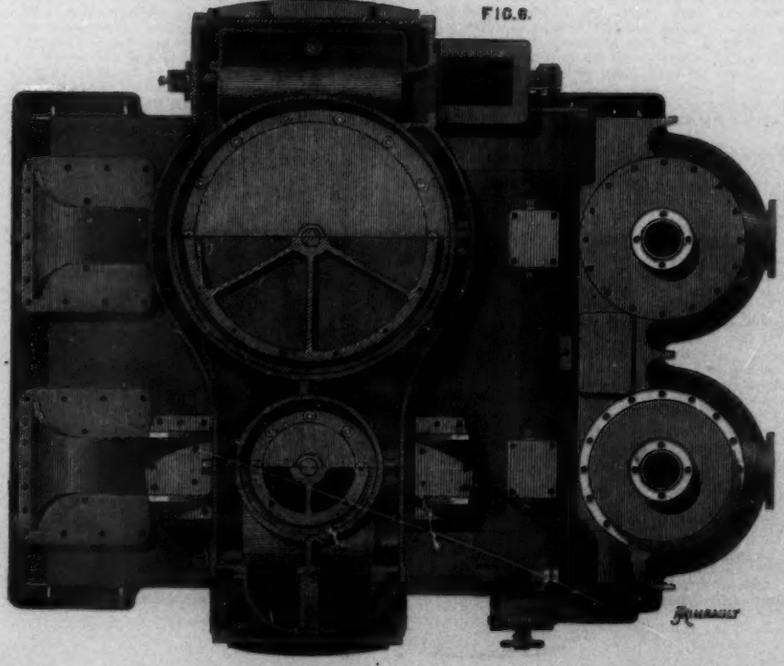
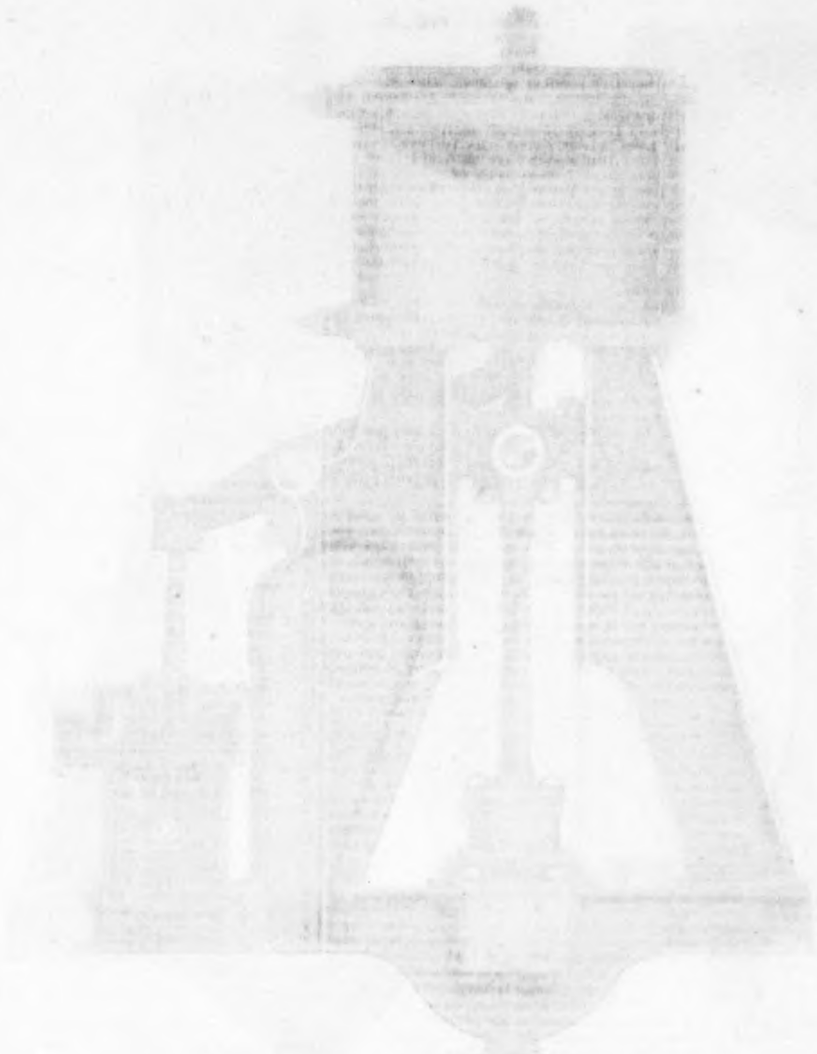
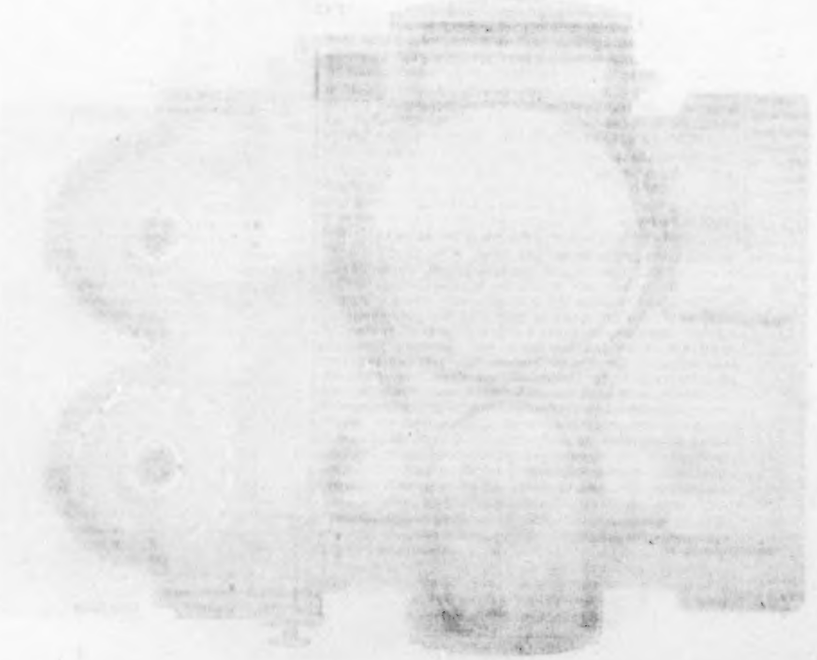


FIG. 6.

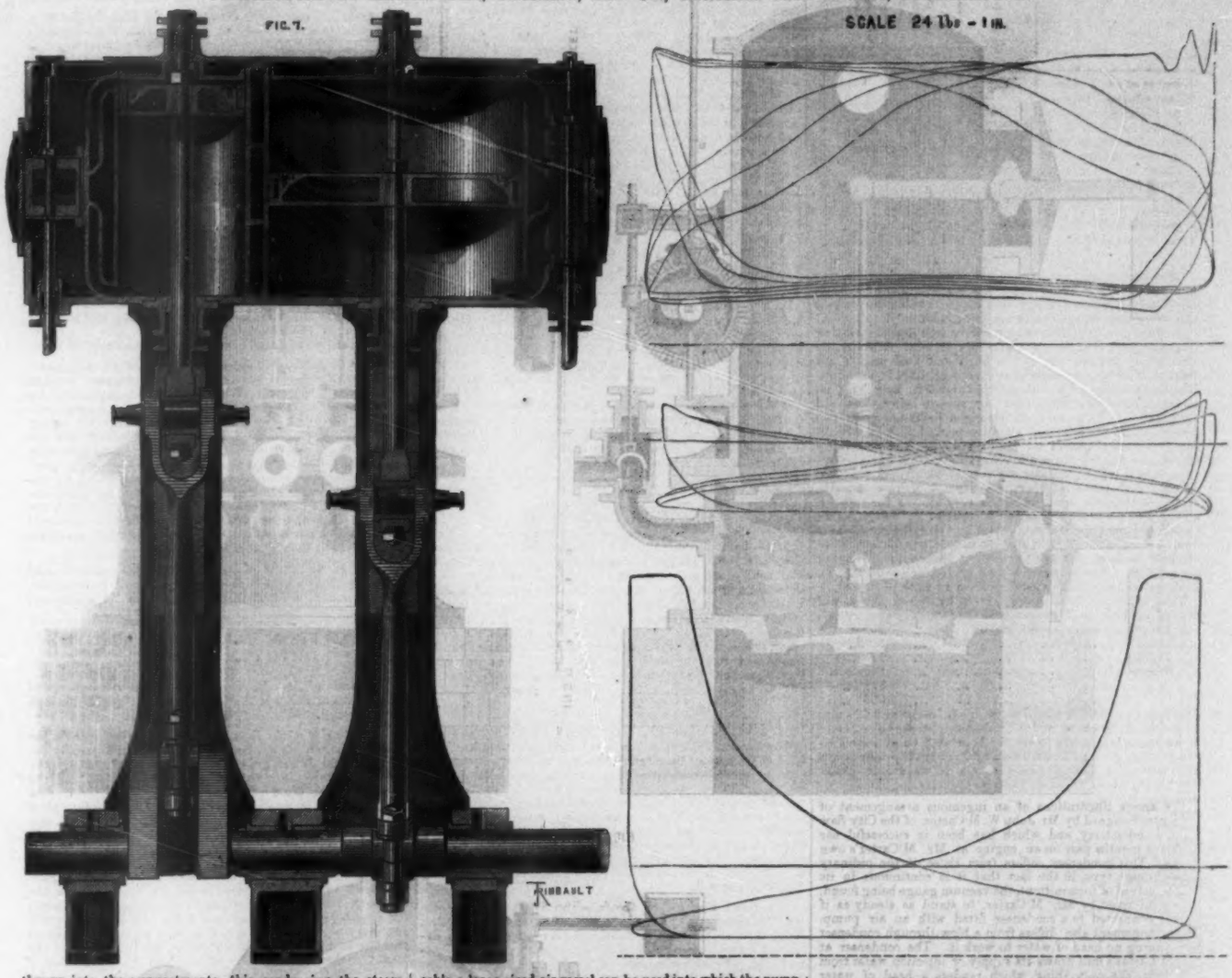






COMPOUND ENGINES OF THE S.S. SIR BEVIS.

CONSTRUCTED BY MESSRS. DAY, SUMMERS, AND CO., NORTHAM IRON WORKS, SOUTHAMPTON.



thrown into the compartments, this condensing the steam used for displacing the air, and thereby forming a vacuum as in the upper vessel. Upon this the upper condenser valve, *e*, opens and allows the products of condensation to fall into the lower compartment.

By the revolution of the tappet shaft, *x*, the air valve, *n*, is then opened, thus destroying the vacuum in the lower vessel, and the atmospheric pressure on the underside of the lower valve being thus counterbalanced, the water opens that valve by its weight, and passes into the waste pipe, *h*. The valve then closes again, by the action of its spring, or weights and lever, and the operation we have described is repeated continuously.

The pipe conducting steam from the boiler to the lower condenser for displacing the air and forming the vacuum, is furnished with a reducing valve, by which the pressure is reduced to one or two pounds above the atmosphere, this being found sufficient pressure for the purpose, and making the quantity of steam used very small, as the lower vessel only requires to be blown out at about every ten or fifteen strokes of the engine. This is regulated by the operation of the tappet gear. The air, steam, and water valves, *m*, *n*, and *o*, are equilibrium valves, and are actuated by tappets on the shaft, *x*, which is driven by bevel gear, as shown, from any convenient part of the engine.

In the apparatus in operation at the City Saw Mills, Londonderry, the upper condenser is 3 ft. 6 in. high by 2 ft. diameter. The lower condenser is 2 ft. 4 in. diameter by 12 in. high. This lower space in the one at work is much too large, as it only should be of sufficient capacity to contain the products of condensation during half a revolution of the tappets, i.e. when the lower vessel is emptying, which it does almost instantaneously, the discharge valve being made of large diameter. The engine in connexion with which the condenser is worked is of the compound type, having two cylinders respectively 15 in. and 21 in. in diameter, each being of 3 ft. stroke.

The injection to the lower condenser is taken from a small cistern overhead, which is supplied with water from the river by a force pump. Where the supply could be had from the town pipes this pump could be dispensed with, or in positions where cisterns would be inconvenient or impracticable a large sized air vessel can be used into which the pump would force the water, and from which the latter would issue into the condenser upon the water valve being opened by the revolution of the tappet shaft. This would be the proper arrangement for marine engines, the water being supplied by the feed or bilge pumps or other convenient means.

For marine engines it would also be necessary to have the condenser placed so that the lower discharge valve would be a few inches above the load water-line, so that the waste water would run off, the tappet gearing being driven off any convenient part of the engine, or by the donkey engine. For hand engines these condensers can be put in any position convenient to the engine not more than the usual height above the injection water, the discharge valve emptying into a sewer or pipe in the usual way.

We also annex to our engravings an indicator diagram taken from the low-pressure cylinder of the engine to which the condenser is fitted, the engine at the time running at 40 revolutions per minute, and driving two saw frames and one circular saw. The boiler pressure was 30 lb. The mean vacuum shown by this diagram is 9 lb., but in the condenser itself the vacuum was at the time 25 in., the injection being drawn from the river (through 150 ft. of pipes), a vertical height of 14 ft. 8 in. The difference between the vacuum in the condenser and that in the cylinder is accounted for by the fact that the steam from the engine has to pass through a water heater and 15 ft. of pipes before reaching the condenser. There is thus much loss of effective vacuum, and the condenser works under considerable disadvantage.

Altogether the arrangement designed by Mr. M'Carter appears to us a very promising one, and we shall be glad to hear reports of its further application. Mr. M'Carter intends, we understand, to shortly apply one of these condensers to a steamer trading from Londonderry, so that data respecting its use for marine purposes will ere long be available. So far, we believe, that no special experiments have been made to determine the quantity of steam used by this condenser; but Mr. M'Carter states that the application of his arrangement has relieved the engine to a very sensible extent. We hope at some future time to be in possession of some more precise data than this, and when we obtain it we shall have much pleasure in laying it before our readers.

COMPOUND MARINE ENGINES.

We publish this week a two-page engraving, and also another view on the present page, of a pair of compound marine engines of 110 horse power nominal, constructed by Messrs. Day, Summers, and Co., of Southampton, for the screw steamship *Sir Bevis*, these engines being similar to those built by the same firm for the Lady Jocyan, and Ybarra, No. 2. Messrs. Day, Summers, and Co. have also made several engines of a similar type, but of 300 horse power nominal, for other steamers, such as the Syria, the Borassia and Danube.

In the engines of the Sir Bevis the high-pressure cylinder is 26 in., and the low-pressure cylinder 52 in. in diameter, the stroke in both cases being 3 ft. The high-pressure cylinder is fitted with Outridge's equilibrium slide valve, as shown in the vertical section and sectional plan. A number of these valves have now been fitted both on marine engines and locomotives, and we hear very favourable reports of their performance. We hope shortly to publish a detailed engraving of this valve, as applied by Messrs. Day, Summers, and Co., but meanwhile we may state that, according to Mr. Outridge's plan, the valve is made to work between a pair of faces formed on castings placed on the ordinary valve face of the cylinder, as shown in Figs. 6 and 7, these castings having continuations of the steam and exhaust passages formed in them. The valve being in perfect equilibrium, the wear is but very slight, and provision is made for taking up such wear as does occur by shifting one of the castings we have mentioned. In the engines we are describing the small cylinder exhausts into a receiver surrounding the two cylinders, and cast in one piece with them, this receiver opening at one end into the valve chest of the low-pressure cylinder. The latter cylinder is fitted with an ordinary double-ported slide valve, as shown in the view on the present page. The cylinders of the engines we illustrate, it will be noticed, are not steam jacketted, but Messrs. Day, Summers, and Co. provide jackets to some of their engines.

The valves of both cylinders are actuated by link motion of the ordinary shifting link type, and the series of indicator diagrams, which we annex, show that the valve gear is well proportioned, and gives an almost exactly equal distribution

of the steam to the two ends of the cylinders. The following Table shows the horse power developed with the different degrees of expansion:

	Full gear.	Nut moved back 2 in. on reversing screw.	Nut moved back 3 in. on reversing screw.
Number of revolutions....	69½	63	60
Mean effective pressure in high pressure cylinder	31.45 lb.	30.5 lb.	28.75 lb.
Mean effective pressure in low pressure cylinder	9.8 „	9.2 „	8.2 „
Indicated H.P. in high pressure cylinder ...	210.7 H.P.	185.4 H.P.	166. H.P.
Indicated H.P. in low pressure cylinder ...	262.8 „	223.6 „	190. „
Total indicated H.P. ...	473.5 „	409. „	356. „

We also annex a theoretical diagram showing the amount of expansion at which the engines of the Sir Bevis are generally worked at sea, this diagram being drawn as if the steam was expanded in a single cylinder only.

Referring to the engravings it will be seen that the framing of the engines is of the steam hammer pattern. The air and circulating pumps, as also the bilge and feed pumps, are worked from beams coupled to the main crossheads, as shown. The surface condenser contains 944 tubes 6 ft. long by ⅝ in. in diameter outside, the condensing surface being thus 1112 square feet. The tubes are arranged horizontally in two groups, as shown, and their ends are packed with tape packing and screwed glands on Hall's system. The remaining features of the engines are so clearly shown by our engravings, that it will be unnecessary that we should enter into a detailed description of them. We need merely remark, therefore, that the arrangement is very simple throughout, and that all parts are thoroughly accessible. The engines, we should add, are supplied with steam by two cylindrical boilers having 1982 square feet of heating surface and 65 square feet of grate surface, these boilers being loaded to 60 lb. per square inch. The propeller is four-bladed, and is 13 ft. 4 in. in diameter, the pitch expanding from 16 ft. to 18 ft.

The Sir Bevis is an iron vessel built by Messrs. Pearse and Co., of Stockton-on-Tees, and is of the following dimensions:

Length between perpendiculars	210 ft.
Beam	30 „
Depth	17 „
Tonnage B.M.	919 tons.
„ gross	878 „
„ register	556 „

The vessel carries 900 tons dead weight of cargo and 120 tons of coal in the bunkers, and with this weight she has steamed at an average rate of 9 knots per hour with an average consumption of 7 tons 12 cwt. 0 qr. 12 lb. per twenty-four hours. The average indicated power at sea is, we are informed, 300 I.HP., which would at the above-mentioned rate of consumption correspond to 1.9 lb. per indicated horse power per hour. This result is, of course, an approximate one, as all records of performance founded on similar data must necessarily be; but in any case a comparison of the gross quantity of fuel consumed with the total work done shows that the engines must be working very economically. The fuel used is Newcastle coal.

A consumption of about 2 lb. per indicated horse power per hour has also been found to represent the performance of the compound engines of 300 nominal HP. already referred to as having been fitted by Messrs. Day, Summers, and Co. to the steamship Syria. This vessel was originally built as a paddle steamer for the P. and O. Company, and she was altered to a screw steamer by Messrs. Day, Summers, and Co. for the Union Steam Company. Her dimensions are:

	ft.
Length between perpendiculars	310
Beam	36
Depth	29
Tonnage B.M.	1988

Her compound engine of 500 horse power nominal, gave on trial an indicated power of 1513 horses, the speed of the ship, as observed at the measured mile at Stoke's Bay, being 12.63 knots per hour. The Syria has made two of the fastest passages to the Cape on record, and with a consumption of 18 tons per day she steams 10 knots per hour.

BELGIAN STEEP GRADIENT LOCOMOTIVE.

To the Editor of Engineering.

Monsieur,—Dans l'article que votre estimable journal (No. du 19 Ct.) consacre à la locomotive pour fortes rampes des lignes de l'Etat Belge, il y a une contradiction manifeste entre le titre et le dernier paragraphe.

Celui-ci établit la part modeste que j'ai prise à l'étude de la machine sous la direction de M. Belpaire, et tous vos lecteurs apprécieront parfaitement la différence qu'il y a entre "faire une étude" et "la diriger."

Le titre, au contraire, en énonçant que la locomotive a été construite à Malines "sur mes dessins" semble énoncer la prétention de m'attribuer la paternité du projet et de faire mienne ce qui est, en réalité l'œuvre de celui qui a bien voulu m'en confier l'étude.

Il doit en avoir l'honneur comme il en a la responsabilité.

Mû par un sentiment que vous comprendrez, je crois devoir vous prier d'insérer la présente dans votre plus prochain numéro.

Agréez contretemps, Monsieur, l'assurance de ma considération distinguée.

A. Stewart.

Bruxelles, Décembre 22, 1871.

VALVES FOR BLOWING ENGINES.

To the Editor of Engineering.

Sir,—I notice a discussion in your journal about a pair of blowing engines at the Solway Iron Works. I was engineer in charge of those engines for two months, and may be permitted to say, that during that time the engines were worked at 34 to 36 revolutions per minute, and the blast pressure was always upwards of 3½ lb.; if the engines were driven up to 40 revolutions per minute, the blast used to be 4 lb. or more. From notes written down on various dates during the time I attended the engines, I can say that at 32 revolutions the blast was 3½ lb., and at 40 revolutions I have observed it 4½ lb. The covering of the roller valves got out and worn in the manner described by Mr. Inglis, after they had been at work for some time; but otherwise, the roller-valves worked well. I have seen the new hinge valves at work, and could not observe any better result from them. I think the arrangement of the roller-valves decidedly the neatest and best. With regard to what your anonymous correspondent "Veritas" says about the impossibility of maintaining 2½ lb. blast at 50 revolutions, with roller valves, your readers will no doubt form their own opinion.

I am, Sir, your obedient Servant,

Walter Hunt, Engineer.

Workington, Cumberland, December 27, 1871.

To the Editor of Engineering.

Sir,—I am much obliged to your correspondent "Veritas" for the full particulars given in your last impression, and would be more so if he will give the numbers and sizes of the new valves. The sketch is to a small scale, and, moreover, it does not give the number of valves in width. Are there four side by side?

Allow me at the same time, in justice to myself, to explain that I did not wish to know the meaning of the sentence "They were coupled, direct-acting, and vertical," but only implied that this information was useless in the absence of other particulars, now supplied.

Yours obediently,

Justice.

EXPRESS LAUNCHES.

To the Editor of Engineering.

Sir,—In the number of Engineering of the 15th inst. there is a notice (under the article of Express Launches) of two paddle steamers on the Clyde which had a speed of over 20 miles per hour; but you omit the name of a third rival boat named Rothesay Castle, constructed by Simons and Company, Renfrew, which ran on the same station and at the same season, and which maintained at least an equal speed to the fastest; this steamer steamed across the Atlantic and is now running in America, and her builders are ready to replace her by another to run 22 miles per hour.

Yours, &c.,

C. T.

NOTES FROM THE SOUTH-WEST.

The Severn Railway Schemes.—A public meeting has been held at Gloucester to consider the six railway schemes for crossing the Severn above and below Sharpness. After some discussion, it was agreed unanimously that the meeting recognising, on the one hand, the great advantages offered by the South Midland line as opening up a new district and affording new means of communication, and also the advantages offered by the Severn bridge line through its connexion with new docks, strongly urged the promoters of each project to come to an arrangement by which mutual opposition might be avoided.

The South Wales Coal Trade.—The South Wales steam coal trade has experienced an important change for the better. Since the late strike, the foreign demand for coal has exhibited a great increase; and notwithstanding the large output, shippers still complain of inadequate supplies. The house coal trade is also very active.

The Proposed Severn Railways.—The following statement shows the moneys sought to be raised by the promoters of the respective Severn railway schemes now before Parliament: South Midland, 3,300,000*l.*; Severn bridge (Portskewet), 1,200,000*l.*; Severn tunnel, 1,000,000; Severn bridge (Blackley), 800,000*l.*; Western Junctions, 500,000*l.*; and Severn bridge (Sharpness), 300,000*l.*; total, 7,100,000*l.* It is not very difficult to foresee that most of these capitals will never, however, have more than a paper existence. Projectors appear to have gone mad during the last two or three months about the Severn.

State of Trade at Newport.—Shipments of iron are being made on a large scale from Newport to the west coast of South America; good freights are also obtained for the United States. Iron ore from Spain is being largely imported, and is becoming an increasingly important branch of local trade. The ocean mail companies are taking large quantities of steam coal.

The Price of Coal.—The price of Somerset coal has been advanced 10d. per ton at the pit's mouth. This is the second advance within the last three months.

Welsh Railway Employés.—The agitation continues among the employés of some of the railway companies having lines in Wales—such as the Taff Vale, the Great Western, the London and North-Western—for a reduction of the hours of labour, an increase of wages, &c. At present it does not appear that any very definite arrangements have been arrived at with the men.

Utilisation of Sewage.—Colonel Shakespear, a director of the Phosphate Sewage Company, had an interview with the Sanitary Committee of the Bath Local Board of Health, on Friday, on the utilisation of the sewage of Bath. In consequence of there being no intercepting sewer, Colonel Shakespear was deterred from submitting any proposition for dealing with the sewage, but he promised to advise the corporation as to the success of the plan adopted by the company with which he is associated, in the treatment of sewage at Tottenham and Leicester.

Taff Vale Railway.—The revenue of this line, in the first 26 weeks of the current half-year, amounted to 149,179*l.* In the corresponding period of 1870, the receipts were 165,776*l.*

Llanelly Railway.—The directors of the Llanelly Railway, in response to a memorial sent to them from the company's locomotive employés, have expressed their readiness to grant the men the nine hours' system. The new arrangement will come into force on and after January 1, 1872.

Coal Exports.—The foreign shipments of coal from Cardiff in November were 190,900 tons; from Newport, 30,483 tons; from Swansea, 41,157 tons; and from Llanelly, 2899 tons. The shipments coastwise were from Cardiff, 73,223 tons; from Newport, 59,220 tons; from Swansea, 16,425 tons; and from Llanelly, 9292 tons.

Bristol Ocean and General Steamship Company (Limited).—A company under this title has been formed in Bristol, and a strong Board of Directors is stated to have been obtained. The capital has been fixed at 250,000*l.* in shares of 25*l.* each.

Armside Engine Company.—The workmen in the employment of this company have presented addresses to the chairman of the Board (Mr. Slaughter), the chief engineer (Mr. A. Sacré), and the works manager (Mr. J. Tannahill), in recognition of the concession of the nine hours' movement. Mr. Slaughter in acknowledging the addresses, said the hour was given by the directors ungrudgingly, and it was resolved upon by the Board even before the men applied for it.

Cardiff Chamber of Commerce.—At the last monthly meeting of this chamber, it was stated that a communication had been received from Sir William Mitchell, expressing his regret that owing to severe indisposition he was at present unable to carry out a scheme proposed by him for laying down a telegraphic wire between Lundy Island and the mainland and thence to Cardiff. The members generally expressed an opinion that this was a great loss to the port. A discussion followed on the delay caused at present by the customs regulation preventing cargoes of iron ore being discharged when coming from foreign ports except during the day time. A committee was formed to draw up a memorial on the subject to be presented to the associated chambers of commerce at their next meeting.

Labour in the Forest of Dean.—The colliers, miners, and part of the ironworkers in the Forest of Dean contemplate, it is said, making a simultaneous demand for an advance of wages.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Market.—Yesterday in consequence of the Christmas holidays the iron market at Middlesbrough was postponed.

The Extension of the Iron Trade.—For several months the Cleveland iron trade has been in a most flourishing condition. Since last year it has grown considerably, and although the total make of pig iron is now upwards of 160,000 tons per month it is far short of the demand. A number of new companies have recently been formed, and are building blast furnaces on the banks of the Tees. In the course of a few months some of the new furnaces will be finished and will be adding their make to the increasing productive power. We regret to say that serious inconvenience is being felt owing to the irregular and insufficient supply of fuel. Now that most of the works are closed for the holidays the managers are devoting their time to making arrangements for a better supply of coal and coke. How far they will succeed remains to be seen. It is very much to be feared that the high price of coke will retard the extension of the iron trade. On the other hand it will be remarkable if capitalists do not avail themselves of the opening there is for additional pits and coke ovens in Durham and come to the rescue of the iron makers. Immense sums of money have been spent in new ironstone mines, and for years to come the supply will keep pace with the demand; but with regard to coal and coke the rapid growth of Cleveland has exceeded considerably the extensions in the coal trade.

The Finished Iron Trade.—Activity still prevails in the finished trade. Rail manufacturers are getting through many of their contracts, but there is still a fair amount of work in the district. Pig iron being quoted at 62*s.* 6*d.* for No. 3 and coal and coke being so high, few rail makers are quoting less than 8*l.* and 8*l.* 5*s.* per ton. The home demand is better than it has been and the inquiries from abroad are such as to lead to the most sanguine hopes for the trade next year. Plate and angle iron is still in great request. Iron founders are busy.

Shipbuilding.—Last year we gave a list of the number of vessels contracted for by the various shipbuilders on the north-east coast. It is gratifying to state that from inquiries we have made we find that the shipbuilding trade of 1872 will even exceed that of the expiring year, gigantic as it has been.

Engineering.—There is nothing particularly new to report in engineering. All the departments are active. For marine work of all kinds there is still an exceptionally heavy demand, and the establishments where this is made the specialty, are full of work for a long time to come.

The Board of Arbitration.—On the 9th July next, the annual meeting of the Board of Arbitration and Conciliation for the North of England iron trade, will be held at Darlington. The board has been rather costly, and has not always been successful in settling differences amicably. On the whole, it has done good, but the expenses being so heavy it is intended to reduce them. In March next, the sliding scale which was alluded to at the Middlesbrough meeting of the board is to come into operation, and it is to be hoped that it will successfully regulate wages.

AGENTS FOR "ENGINEERING."

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UNITED STATES: Van Nostrand, 23, Murray-st., New York.
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RUSSIA: at all Post-Offices in the Empire.
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BERLIN: Messrs. A. Asher and Co., 11, Unter den Linden.
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Advertisements cannot be received for insertion in the current week later than 5 P.M. on Thursday. The charge for advertisements is three shillings for the first four lines or under, and eight pence for each additional line.

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ENGINEERING is registered for transmission abroad.

THE "ENGINEERING" DIRECTORY is published this week on the thirteenth page of our advertisement sheet.

NOTICE TO AMERICAN SUBSCRIBERS.

In consequence of the great increase in our American connexion, we have found it necessary to establish a branch office in the United States. Communications may in future be addressed to MR. GEORGE EDWARD HARDING, C.E., *of* 176, *Broadway, New York, who is our accredited representative.*

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of* 1*l.* 14*s.* 8*d.* ($8.32, *gold*) *per annum, payable in advance.*

DIED, on the 23rd inst., at Regent Terrace, Gateshead-on-Tyne, John Hosking, M.I.M.E., aged 63. For upwards of 20 years chief engineer for Messrs. Hawks, Crawshay, and Sons, engineers and iron manufacturers, Gateshead.

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ENGINEERING.

FRIDAY, DECEMBER 29, 1871.

NARROW GAUGE ROLLING STOCK.

WE have republished on another page of the present number an article on this subject from the Chicago *Railroad Gazette*, and we have done so partly because the article contains many interesting facts relating to American rolling stock, and partly because certain portions of it contain arguments opposed to the views which we have advanced respecting the saving of dead weight of rolling stock obtainable by adopting a narrow gauge for lines intended to accommodate a small amount of traffic. To the arguments brought forward by our contemporary we now propose to reply.

The main ground taken by our contemporary is that, practically, the proportion between the dead weight and carrying capacity of rolling stock is independent of the gauge, so long as the class of accommodation afforded remains the same in all cases; whereas we maintain that this proposition is only approximately correct so long as no restriction is placed upon the size of the vehicles to be built for the broad-gauge lines, and it is this really which constitutes the point of difference between us. We have repeatedly shown that there has been built for the 4 ft. 8½ in. gauge rolling stock having as little dead weight in proportion to the load carried as any narrow gauge stock of an equally substantial class; but in all cases where this result has been obtained the total capacity of each vehicle for the 4 ft. 8½ in. gauge has been vastly greater than that for the narrower gauge, and hence the stock has been less applicable for lines having to accommodate a light traffic. Thus we may compare the carriages on the Festiniog Railway, weighing but 2 cwt. per passenger carried, with some of the light French railway carriages shown at the Paris Exhibition of 1867—carriages which, while affording rather more cubic capacity per passenger than those on the Festiniog line, weighed a few pounds less. But, whereas the Festiniog carriages carry but twelve passengers each, the French carriages accommodate sixty, and thus the former carriages might be run full on a line where the traffic would not be sufficient to half fill the latter.

These arguments apply, in a far stronger degree, to merchandise stock than to passenger carriages. In the case of lines traversing thinly populated districts, and intended to accommodate a small traffic, it is, we consider, particularly necessary that the vehicles forming the goods-carrying stock should be of such size as to enable them to be readily handled at stations, and to insure their being always run with approximately full loads. In the vast majority of such lines, wagons weighing from a ton to 25 cwt. empty, and carrying from two and a half to three times their own weight of minerals, or about one and a half times to twice their weight of ordinary goods, will be found not only amply large enough for the nature of the traffic, but really as large as can be handled readily with the small staff which it pays to maintain at the stations of such railways as those of which we are speaking. Of course these small wagons would have but four wheels; and notwithstanding our contemporary's statement that four-wheeled vehicles have not been found to answer in America, we feel convinced that such stock is that best adapted for the majority of light narrow gauge railways. Exceptions to this rule will of course occur, as, for instance, in cases where there is a large through traffic from one terminus or important station on a line to another. In such an instance where large wagons can be sent right through with full loads, and where an ample staff is necessarily maintained at each of the stations, so that these large wagons can be readily handled, the bogie stock can often be advantageously introduced. We are not familiar with the traffic to be accommodated on the Denver and Rio Grande Railway; but it is possible that it may include some features of the kind just mentioned which will justify the employment of the large box cars of the class illustrated by us on page 414 of our last number. Otherwise we must confess that we do not see what advantage is to be obtained from employing cars which, weighing as they do from 9 to 12 tons when loaded (according to the nature of the freight carried) must be as unhandy at stations as ordinary wagons for the 4 ft. 8½ in. gauge.

It is urged by our contemporary that the body of the Denver and Rio Grande box wagon might be placed upon trucks suited for the 4 ft. 8½ in. gauge without any material increase of weight, and that on the latter gauge the same floor area might be obtained with a reduction of weight by modifying the proportion of length to breadth. As regards the first of these propositions we may merely say that the fact that the weight would be increased by the change by a certain amount, however small, without any counterbalancing advantage, is itself an argument in favour of the narrower gauge; while, as regards the second point, we may direct attention to the fact that, although our contemporary proposes to shorten the longitudinal timbers three times as much as he lengthens the transoms, yet that he takes no account of the fact that the aggregate sectional area of the timbers lengthened is three times as great as that of those shortened, so that this portion of the change involves neither gain nor loss. Undoubtedly something would be gained in the aggregate weight of the sides and ends, but it appears to us probable that this would be all swallowed up in the increase it would be necessary to make in the scantling of the transverse timbers of the floor and roof.

All this, however, is beside the question at issue as we refuse to accept the Denver and Rio Grande wagon as an example of what we consider narrow gauge stock should be. The same remark also applies to other examples of large stock for narrow gauge lines, which our contemporary has at other times advanced in support of its views. What we maintain is, that the small wagons which we advocate as being the best suited for the general traffic of light railways cannot be built for the 4 ft. 8½ in. gauge with such a small proportion of dead weight, as is the case when they are made for gauges of 3 ft. or 3 ft. 6 in. As the wagons become larger so does the advantage possessed in this respect by the narrower gauge diminish, until ultimately as the increase of size goes on, it is the broader gauge which, in its turn, has the advantage. In conclusion we may remark that the weight of the Denver and Rio Grande carriages, amounting, as it is stated to do, to 441 lb. per passenger, supplies another argument against the employment of bogie stock, the four-wheeled carriages built a short time since by the Bristol Wagon Company from Mr. Fairlie's designs for the Dunedin and Port Chalmers Railroad of New Zealand, weighing but 300 lb. per passenger in the case of the first class, and 232 lb. per passenger in that of the second-class carriages. These carriages, which were for the 3 ft. 6 in. gauge, were 19 ft. 6 in. long by 7 ft. 6 in. wide, and were each divided into three compartments, each carrying eight first or ten second-class passengers.

PUBLIC WORKS IN PARIS.

THE Director of Public Works in Paris, M. Alphand, has recently prepared a voluminous report, in which he sets forth, in considerable detail, the organisation of the Service of Works, the duties, and the management of the various branches of this important department, the expenses it has incurred, the results it has achieved, and, lastly, the sums that have been allotted to it for the coming year. The document is full of interesting information on the various duties of this administration of Paris. Till this time but little authentic information on the subject has been published, and the report of M. Alphand contains statistics of interest as regards the past, and very valuable for the future. And, first, the author thus defines the service of public works in Paris. It is charged, he says, to insure public convenience and safety, by the good condition of public roads, and their development according to the necessities of the traffic, to promote public health by sanitary improvements, by the removal of refuse of all kinds which is produced by men and animals, by the regulations needful to guarantee the well-being of the inhabitants, as well as in their dwellings as in the streets, by the necessary distribution of water, by the establishment of public recreation grounds, and of tracts covered with vegetation, forming vast reservoirs of pure air, indispensable to the salubrity of the city, lastly, by the erection of public monuments, and the production of works of art and of history, so as to inspire and to maintain in the population a sentiment for good, and a respect for the past.

These varied responsibilities had been divided, since 1855, between seven engineers occupying a high position in the administration. This organisation, justified by the impossibility of finding an administrator capable of attending to all the requirements of so great a service, in the middle of the feverish activity characteristic of works in Paris, presented, however, this inconvenience, that it brought about discontent, misunderstanding, prejudice, and a want of accord. When it was well understood that the financial situation of the city of Paris imposed upon the administration, the duty of arresting, or at least of reducing, the progress of public works, it was resolved to re-establish a union between the various services, by placing in the hands of one officer, at once administrator and constructor, the whole of the duties previously divided between seven heads of departments. But the old direction of water supply, of sewers, and of scavenging, has been maintained as a separate service, and it is still administered by M. Belgrand, the well-known engineer, who during fifteen years, has given ample proofs of his fitness for the position.

The municipal service confided to the direction of works consists of two great divisions. The first includes all matters relative to public thoroughfares and buildings; the second includes all the works of architecture and the arts. Of course the staff employed in these divisions is a large one. In 1870 it comprised 1124 employés, whose combined salaries amounted to 3,285,694 francs, and for 1872 it is proposed to employ 946 persons, costing 2,682,450 francs, being a reduction of 178 employés and of 603,244 francs, or 18 per cent. on the outlay.

The first service to which M. Alphand alludes is that of the public ways, and he explains the principles which guided the designers of the plan of new Paris. Almost all the streets being perpendicular or parallel to the Seine, and these streets being too narrow, it was necessary to remedy the evil by

the construction of new roads. But these new roads involved longer routes, since they followed the diagonals of the rectangles formed by the streets, parallel with, and perpendicular to, the river. Several boulevards were constructed to obviate this difficulty, and other similar works remain to be completed. Again, other alterations had for their object the improvement of communication between the centre of the city and some of the outlying districts.

These new routes were made, as far as possible, in a straight line; for the most part their longitudinal section was arranged so that at each end, and along all their length, the whole of the roads should be visible. This condition, besides the beauty it imparted to the street, was imposed from strategic motives; but it has often been difficult to fulfil it, and it has led sometimes to the lowering, by 27 ft. or 30 ft., of a large area; or, on the other hand, to filling up existing buildings to a height of several metres. Necessarily this system was a very costly one, but it presents many advantages to traffic.

The net expenses of these great works amounted to no less than 884 million francs, of which 286 millions will have to be paid on the 1st January, 1872. M. Alphand proposes to settle for completed works, and to finish only some others in course of execution. He proceeds to recommend to the Municipal Council the examination of each of these schemes, and to distinguish amongst the non-completed roads, those which ought to be finished and those which can be abandoned without great inconvenience; and amongst the roads not yet commenced, but for which the land has been already purchased, those which it will be advisable to go on with, and those that ought to be abandoned.

The maximum height of houses in Paris is fixed by law between the limits of 38 ft. 5 in., and 57 ft. 6 in. according to the size of the streets on which they stand. In streets or boulevards 65 ft. 7 in. wide as a minimum, exceptional authority is given to builders to construct houses 65 ft. 6 in. high, on condition that in this height are contained, besides the ground floor, five distinct stories.

The service *des carrières* is an important addition to the road department. It is charged with the direction of the work of preparing the ground on which public buildings are to be erected, to exercise a surveillance on quarrying and stone workings, and to maintain and inspect the catacombs.

Lastly comes the sanitary service, which has to look after the preservation of life and health, and the necessary measure of cleansing unhealthy quarters. This service makes about 4000 inspections yearly. It has also the cesspools under its charge, their construction, repairs, and emptying; and it attends to the cleansing of houses, the façades of which ought to be restored once at least every ten years.

The second service of the Director of Works in Paris includes five divisions, that of the pavement, the side walks and alleys, street cleaning and watering, new paving, and the maintenance of non-paved thoroughfares.

There are in Paris three kinds of roads, pitched, metalled, and asphalted. The maintenance of these costs about 7,844,500 francs per annum. Even these high figures threaten an increase every year, with the growing intensity of the traffic and the development of the new thoroughfares, so that proper measures should be taken to restrict the outlay as far as possible. The metalled roads are the most costly, the outlay for maintenance amounting in some roads to 16 francs per square metre per annum, so that the employment of metalling should be restricted as far as possible, and new systems should be encouraged. Of late pitching has been substituted for metalling, and in 1872 there will be 400,000 square metres of roadway so altered. The total area of paving in Paris amounts to 6,083,000 square yards, and there are 411 inspectors always employed to maintain this surface, the expense of which amounts to 2,735,000 francs. The stone comes from the quarries belonging to the city, and worked by it. But for the more crowded streets special stone is brought from Belgium and from Autun, whilst the hard granite from the Manche, the Vosges, and Mayenne are also employed.

The American Cotton Manufacture.—In the Fall River district, in Massachusetts, 19 new cotton mills are now building, and some of them are nearly completed. The entire number of cotton mills in the district will thus be increased to nearly 50, representing a capital of about 50,000,000 dols.

STEAM EXPANSION CURVES.

In the articles and letters on steam engine coefficients which have recently appeared in our pages, frequent reference has been made to curves representing the expansion of steam according to different laws; and as it is in many cases desirable to be able to draw such curves on indicator cards we propose to describe some modes of doing this easily and rapidly.

When the expansion takes place according to Mariotte's laws, the pressure during expansion varying inversely as the volume, the expansion curve is, as is well known, a common hyperbola, and when the amount of clearance is known this curve can be very readily laid down in the manner shown by Fig. 1. In this figure let the height, $c\,d$, represent the total pressure of the steam at the point of cut-off, or at some point subsequent to the cut-off if the position of the latter be not accurately known. Also let $b\,c$ represent the length of the

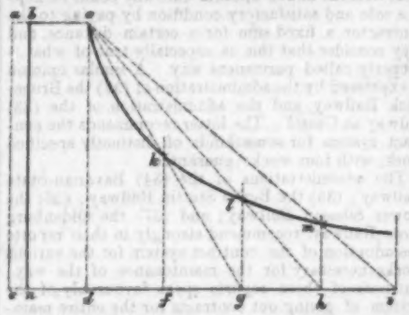

Fig. 1.

cylinder filled with steam of the pressure, $c\,d$, and let $a\,b$ represent the clearance spaces. Then the area $a\,c\,d\,e$ will represent the quantity of steam to be expanded. Next on the base line, $e\,i$, mark off a series of spaces, $d\,f$, $f\,g$, &c., each equal to $e\,d$, and at the points, f, g, h, &c., erect perpendiculars, as shown. Then draw lines from the point, e, to each of the points, g, h, i, &c., and the point at which each of these oblique lines intersects the perpendicular next to that to the base of which it is drawn, is a point in the desired curve. For instance, k, l, m, are such points in Fig. 1. The curve may of course be extended indefinitely towards the right according to the length of stroke and degree of expansion.

If the conditions of working are such that the steam, when expanding, falls in pressure in proportion to the reciprocal of the tenth power of the ninth root of the ratio of expansion, or, as expressed in symbols, if $p \propto r^{-\frac{10}{9}}$, then the curve cannot be laid down geometrically, and it is necessary to adopt another plan. One method which is convenient in certain cases is to employ a table giving the heights of the 2nd and 3rd ordinates, &c., in percentages of the initial pressure, or, in other words—referring to Fig. 1—giving the heights, $k\,f$, $l\,g$, $m\,h$, &c., in percentages of the height, $c\,d$. We herewith give

Table showing the Lengths of Ordinates for Expansion Curves, expressed in Percentages of the Length of the First Ordinate or Initial Pressure.

Number* of ordinates.	$p \propto r^{-\frac{10}{9}}$.	$p \propto r^{-\frac{11}{9}}$.
1.5	63.735	66.02
2	50.87	47.87
2.5	36.10	37.78
3	29.49	31.12
4	21.41	22.92
5	16.72	18.09
6	13.60	14.90
7	11.507	12.65
8	9.959	10.98
9	8.703	9.68
10	7.763	8.66
11	6.964	7.83
12	6.325	7.14

such a table containing such percentages for curves corresponding to the law, $p \propto r^{-\frac{10}{9}}$, and also for curves following the law, $p \propto r^{-\frac{11}{9}}$; but we ourselves prefer to substitute for the table diagrams, from which the lengths of the ordinates can be directly measured. Two such diagrams are shown by Figs. 2 and 3, the former being for curves corresponding to the law, $p \propto r^{-\frac{10}{9}}$, and the latter for curves representing expansion according to the expression, $p \propto r^{-\frac{11}{9}}$.

The mode of using these diagrams is as follows: Let us suppose that it is required to draw a curve

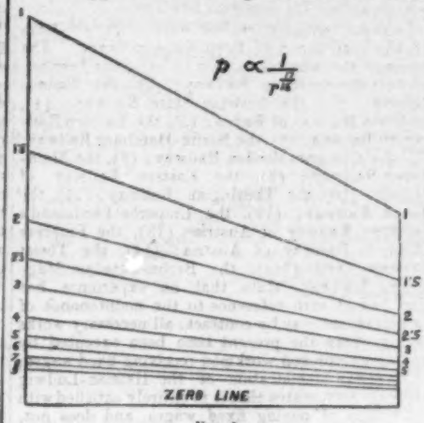

Fig. 2.

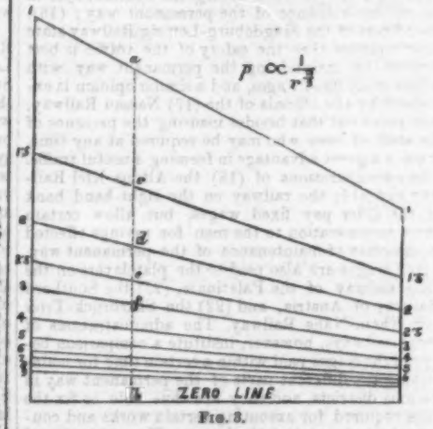

Fig. 3.

representing expansion according to the law $p \propto r^{-\frac{10}{9}}$. Then draw the area representing the volume of steam to be expanded and erect the perpendiculars $f\,k$, $g\,l$, &c., as in Fig. 1; but instead of obtaining the points in the required curve by drawing oblique lines as in that figure, measure off the lengths of the ordinates from Fig. 2 in the following manner: Parallel to the base line of Fig. 2, and at a distance above it equal to the height of the ordinate representing the initial pressure, draw a line cutting the top line, 1, 1, of the figure, and from the point at which the intersection takes place let fall a perpendicular to the base line. Thus in Fig. 2 let $a\,b$ be a perpendicular let fall in this way, the height $a\,b$, representing the initial pressure of the steam to be expanded. Then the heights on this line, measured from b to the points of insection of the lines $a\,b$ with the oblique lines, 2, 2; 3, 3; 4, 4, &c, will be the heights of the 2nd, 3rd, and 4th ordinates, and so on. Thus with the initial pressure $a\,b$, $c\,b$ will represent the pressure of the steam when it has expanded one and a half times, $d\,b$ when it has expanded twice, $e\,b$ when it has expanded three times, &c. The other diagram, Fig. 3, is of course used in the same way.

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* The numbers 1.5 and 2.5 are applied to ordinates supposed to be situated midway between ordinates 1 and 2, and 2 and 3 respectively.

GERMAN RAILWAYS.

The Construction and Maintenance of Permanent Way.

(*Concluded from page 366.*)

An important question which has been considered by the Association of German Railway Engineers and the one to which we intend next to direct attention, is that relating to the advisability of having lines maintained by contract. With reference to this question an inquiry was addressed to the various members of the Association as to what experience had been gained concerning the maintenance of permanent way by contract, and it was also asked what system of contracting had been found the best, namely; 1st. Whether it had been found advisable to have the line main-

tained at a fixed price for a certain distance?; or 2nd. Whether it was better to contract for the maintenance of the line at a fixed price for each different kind of work to be done? It was also asked, what description of work should be executed by contract?

To these inquiries replies were obtained from the administrations of forty-three railways. The replies of the administrations of: (1), the Breslau-Schweidnitz-Freiburg Railway; (2), the Taunus Railway; (3), the Austrian State Railway; (4), the State Railway of Baden; (5), the Eastern Railway of Bavaria; (6), the Berlin-Hamburg Railway; (7), the Cologne-Minden Railway; (8), the Main-Weser Railway; (9), the Eastern Railway of Prussia; (10), the Thüringian Railway; (11), the Wema Railway; (12), the Emperor Ferdinand's Northern Railway of Austria; (13), the Empress Elizabeth Railway of Austria; (14), the Theist Railway; and (14*a*), the Berlin-Potsdam-Magdeburg Railway, state that no experience has been gained with reference to the maintenance of the permanent way by contract; all necessary works having up to the present time been executed by regularly employed workmen receiving fixed wages; (15), the administration of the Hessian-Ludwig Railway, also, states that it is entirely satisfied with the results of paying fixed wages, and does not, therefore, feel inclined to try the contract system for the maintenance of the permanent way; (16), the officers of the Magdeburg-Leipzig Railway state their opinion that the safety of the traffic is best secured by maintaining the permanent way with labourers at fixed wages, and a similar opinion is expressed by the officials of the (17) Nassau Railway, who point out that besides insuring the presence of the staff of men who may be required at any time, there is a great advantage in forming a useful traffic. The administrations of (18) the Altona-Kiel Railway and (19) the railway on the right-hand bank of the Oder pay fixed wages, but allow certain extra remuneration to the men for savings effected in the costs of maintenance of the permanent way. Fixed wages are also paid to the platelayers on the (20) railway of the Palatinate, (21) the Southern Railway of Austria, and (22) the Saarbrück-Trier and Rhein-Nahe Railway. The administrations of these railways, however, institute a comparison between the wages paid within a certain time for maintaining the different parts of the permanent way in various districts, and they are thus able to fix the time required for executing certain works and consequently the cost of the latter. If no exceptional circumstances have to be taken into consideration the men have to perform the work within the stipulated time. Such an arrangement is stated to have given the highest satisfaction especially on the Southern Railway of Austria.

The administration of the (23) Main-Neckar Railway has made several trials in letting by contract certain works for repairing the permanent way; but the results obtained have been highly unsatisfactory. The foregoing are the results of the reports of those railways which decline to let by contract the maintenance of their permanent way. There are, however, other lines which report in favour of the contract system, and in these reports we find the following observations and results.

The administration of (24) the Siebenbürger Railway accepts contracts for the maintenance of the way, under the conditions that (1) the bed of the way is consolidated; (2) that the prices for the contracts are based upon experience formerly obtained; (3) that the contractor is a man of proved ability; and (4) that the inspector of the line or district uses his influence in an energetic manner, and receives a certain percentage of the savings effected by the contract system. Under such an arrangement, it is affirmed that only advantages and never disadvantages, are obtained. If contracts are given out for entirely maintaining a certain length of the line, this distance is seldom fixed at more than two German* miles, and independent tenders are then asked for maintaining this distance during the summer months and the winter months respectively. The permanent way in or near stations also is partly maintained by giving out contracts for the performance of special works, such as: (1) the keeping in a proper and safe state of the lines of rails within the stations for a stipulated price per yard; (2) the maintenance of the points and crossings; (3) the renewal of the sleepers at points and crossings; (4) the maintenance of switches in proper order; and (5) the renewal of different parts of the way.

The administrations of (25) the Berlin-Anhalt Railway; (26) the Magdeburg-Halberstadt Railway; (27) the Upper Silesian Railway; (28) the Saxon State Railway; (29) the Tilsit-Insterburg Railway; (30) the Galizian Charles Ludwig Railway; and (31) of the Berlin Görlitz Railway, state in their reports that contracts have been given out with advantage for the laying of new rails, or for the entire renewal of the existing lines; also for the renewal of sleepers and keeping open of the drainage, in fact, for all such works as could be distinctly specified. Every one of these railways, however, is opposed to the system of letting the entire maintenance of the way by contract, and very especially to give the contracts to servants of the railway companies, such as station masters or district engineers. Some of these administrations express a most decided doubt whether the way could be kept in a safe and satisfactory condition by paying to the contractor a fixed sum for a certain distance, and they consider that this is especially true of what is properly called permanent way. A similar opinion is expressed by the administration of (32) the Brunswick Railway, and the administration of the (33) railway at Cassel. The latter recommends the contract system for some kinds of distinctly specified work, with four weeks' guarantee.

The administrations of the (34) Bavarian State Railway; (35) the Berlin Stettin Railway; (36) the Lower Silesian Railway; and (37) the Oldenburg State Railway, recommend strongly in their reports the adoption of the contract system for the various works necessary for the maintenance of the way; but none of these reports speak favourably of the system of giving out contracts for the entire maintenance of a certain length of the line. The Bavarian State Railway has tried this latter system, and has found that the only way in which success can be obtained consists, not in letting a contract for a length of, say, about 2 German miles to one contractor, but in trusting the maintenance of a short portion of the line, say about ¼ of a German mile (equal to about 1¼ English miles) to the hands of a small body of labourers, all of whom receive equal portions of their combined earnings, with the exception of the foreman, who gets a premium of from 3 to 5 per cent. The officials of the Bavarian State Railway hope in this manner to give the labourers more interest in their work, and to form also a body of skilled men, to whom perhaps at some later period a greater length of the line could be safely trusted. Of course, in this case, much depends upon the ability of the district engineer, who has to examine the works executed, and has to certify for the payments which are made, these payments, however, being made only after the guaranteed time of six weeks has passed.

On (38) the Hanoverian State Railway contracts for maintaining certain lengths of the permanent way have been given out for some time, and certain sums varying in amount have been paid per mile for the entire maintenance. Although the state of the line was found to become worse under this system after a certain period, yet stricter regulations and superintendence did much to improve it again, especially after it was made a rule that the contractors should deposit a certain sum of money as guarantee for the proper execution of the work. The great difficulty in this system of contracts consists in fixing the correct price for the maintenance of a certain portion of the line, whilst it it much more easy to agree about the sum to be paid for a certain class of work only, such as renewing sleepers, &c. Both systems of contract have been adopted by the administration of the Hanoverian State Railways, and according to circumstances the one or the other is adopted for maintaining the way of this railway.

The report of (39) the Wurtemburg Railway expresses a similar opinion, and states further that the contract system which was formerly adopted for the performance of certain works only, has been extended during two years to the maintenance of certain portions of the permanent way. Up to the date of the report each district engineer was at liberty to keep the line within his district in a proper state by labourers receiving fixed wages, but in a short time the contract system was to be generally adopted. The advantages of the latter are affirmed by this administration to be: 1. Better and more careful work, and independence from the wants of labourers; 2. Better wages for the men, and a saving of about 30 per cent. in the amount paid formerly in weekly wages; and, 3. Better condition of the line, and less frequent repairs on account of the guarantee time of four weeks. In order to obtain, however, these advantages, all the men must have an equal interest in the good performance of their work, and this is chiefly obtained by an uniform distribution of the profits. The Wurtemburg Railway recommends the contract system highly.

A somewhat different opinion is expressed by the administration of (40) the South-North German connecting railway (Sud-Nord deutsche Verbindungs Bahn). The maintenance of the permanent way of this line is given out by contracts, but a distance of about two German miles is given to one contractor, who has been formerly a foreman platelayer, and who even in his new position is definitively engaged by the railway company. He alone is responsible for the work, and receives the contract sum. This sum is fixed according to the portion of the line, the number of lines of rails, joints, crossings, switches, gradients, material of ballast, the local wages for labourers, and the number and speed of the trains. The contracts are, moreover, divided into two sections—the one includes the keeping in a proper state of the gauge, joints of rails, and the renewal of worn-out sleepers, chairs, and rails; the other section refers to all those works which are connected with maintaining the proper state of the road-bed; as, for instance, the filling in of the neccessary quantity of fresh ballast, the keeping open of the drains, &c. The contractor is paid every month, and at the beginning of the winter, when the whole line is carefully examined by the chief engineer, the contractor, whose district is found to be in the best state, receives a premium. After an experience of ten years the chief advantage of this system is found in the economy with which the permanent way is maintained. The selection of careful men and the expectation of profits and remuneration are the best guarantees for a satisfactory performance of the work. The uninterrupted superintendence of the district engineer and the responsibility of the contractor will, it is considered, always improve the state of the line. On the other hand, the disadvantages of the system are the difficulties in fixing a proper price for the contract, and the inability of the contractor to deposit a sum of money as guarantee for the careful performance of his work. The reports of (41) the Westphalian Railway, and, finally, of (42) the William Railway coincide in their opinion with that expressed in the last report noticed.

The Westphalian Railway has for several years entered into contracts for maintaining the line of the district Rheine-Emden; the contract is continually made with one man for one mile per year. The state of the line is carefully investigated at the beginning and at the end of the year, and only the lowest rate of wages is paid during the time of the contract, and the balance a certain time after the end of the year. The advantages claimed are the same as formerly stated.

The reports of twenty-eight of these railway administrations may be classified in the following manner:

A. Reports which recommend simply the maintenance of the line by labourers receiving fixed weekly wages (15-17.)

B. Reports which recommend the introduction of a system according to which the labourers receive premiums or bonuses in proportion to the savings effected in the maintenance of the line (18-22.)

C. Reports which state that only some well-known classes of work have been given out to contracts (23-31.)

D. Reports which recommend the maintenance of the permanent way by letting the various classes of work connected with it in single contracts (32-39.)

E. Reports which state that the entire maintenance of the permanent way is done by contract (40-42.)

The conclusion drawn by the Association from the reports referred to above, is that the results of experience show that the entering into contracts for the maintaining of the lines is under certain circumstances and conditions more advantageous than maintaining by labourers receiving fixed weekly wages. These circumstances and conditions are:

1. Well bedded ballast or under structure.

2. No extraordinary constructions of the line, the maintenance of which might be connected with difficulties on account of unforeseen occurrences.

* A German mile=8237.8 yards=4.682 miles English.

3. Uniform traffic over the line.
4. Confining the contract work to the summer months.
5. Ascertaining the exact amount of work to be done.
6. Exact stipulation of the contract sum.
7. The employment of skilful and trustworthy men.
8. Uniform distribution of the profits among the men.
9. Combined guarantees for the good performance of the work and for the safety of the traffic.
10. Compensation of the district engineers for the increased amount of work in connexion with the superintendence of the contract work.

Under these circumstances and conditions the contract system is considered to offer the following advantages:

1. Reduction of costs for maintenance of permanent way.
2. Better performance of the work, and, therefore, a better state of the line with its desirable consequences as regards the traffic.
3. More rapid execution of the necessary works.
4. Training of skilful labourers.
5. Higher earnings for the men.

But if the above circumstances and conditions exist only partly, the advantages are less, and the following disadvantages may even be the consequences of the adoption of the contract system.

1. Increase of the cost of maintenance of the permanent way.
2. Successive deterioration of the state of the line.
3. Uncertain earnings of the men.
4. Disagreement between superintending engineer and contractor.

Contracts for the entire maintenance of certain lengths of the line are considered to be only preferable to contracts for specified classes of work in the case of lines which require generally an uniform amount of repairing, and over which the amount of traffic is constant. If under those circumstances a strict control is kept over the contractor, this system of contract work may have the advantage of greater cheapness and better maintenance of the line.

Contracts for specified classes of work offer, however, it is considered, greater and better advantages, for the various works may be contracted for according to the special requirements of the case, whence the line can be always kept in its proper state at reduced expenses, which can be stipulated beforehand with better accuracy, whilst the workmen run less risk, and become more satisfied with their work. The only disadvantage of contracting for the various classes of work necessary for the maintenance of the line is considered to consist in the increased labour of the superintending department.

Another question relating to permanent way maintenance which has been submitted to the members of the Association is, "What system of control for the inspection of their respective districts on the part of the linesmen has been found to be the best?"

This question has been answered by the administrations of forty railways. On most railways the linesmen have to walk over their district before or after the passage of each or a number of trains, according to traffic arrangements, and, in order to control now these regular inspections, twenty-four railways have arranged different means.

First. The Berlin-Anhalt, Berlin-Görlitz, Berlin-Hamburg, Berlin-Stettin, Brunswick, Hanoverian, Hessian, Magdeburg-Halberstadt, Magdeburg-Leipzig, Lower Silesian, Upper Silesian, and several other railways have adopted numbered plates, one of which has to be fastened by the linesman, after each inspection, to a post at the end of his district, whilst the remaining numbers have to be placed outside his cottage in such a position that they can easily be seen from the train. The use of these numbered plates is carried out according to three different systems, namely: (1) the man begins in the morning with number one, and takes the following number for his next inspection; (2) the man takes always that number which corresponds with the number of the next train; or (3) the numbers indicate the hour at which the last inspection of the district took place. The correct numbers have to be examined either by the various foremen of permanent way, or by the chief guards of the passing trains, and in order to make this examination possible during the night the posts with the numbered plates must occupy such a position that they are made visible by the lights from the locomotive or carriages.

Second. The administration of the Breslau-Schweidnitz Railway has lately substituted coloured plates for those with numbers, and six inspections have to be made daily according to traffic arrangements, but always, if possible, before the passage of passenger trains; the first and fourth inspections have to be proved by white plates, the second and fifth by red plates, and the third and sixth by blue plates.

Third. The State Railways of Wurtemburg and Bavaria have used alternately one circular and one square plate with the corresponding number of the linesman. The latter railway has, however, lately adopted the system first described.

Fourth. The State Railways of Baden have their lines inspected once during the day. Each district is divided into a number of sub-districts or beats, which extend generally from the cottage of one linesman to that of the next. A so-called inspection card has to be carried from man to man, and every man has to sign his name and the hour of delivery on the card. The time of starting is fixed for the first man, and the last man of the sub-district has to deliver the card to the foreman of the district, who returns it per train to the chief district engineer for examination. This system of controlling the inspection of the line has answered very well. All the systems mentioned above are actually in use, although some of the railways propose some rather complicated improvements.

The administrations of sixteen railways report that they do not control the inspection of the line by the linesman, on account of the entire uselessness of such a control, for, as stated by the Siebenburger Railway, nothing is easier for a lazy man to have the control plates or tickets carried about by either his wife or child. Only trustworthy men ought to be appointed as linesmen, and the district engineer should inspect the line as often as possible, and at unexpected times. Carelessness on the part of the watchman should, when discovered, be punished by heavy fines or dismissal, whilst a premium ought to be given at the end of the year to those men whose part of the line has always been found to be in proper order. The men are thus encouraged to be as careful and attentive in their inspection as possible, an end which is not obtained by causing the men to carry numbered plates from one end of the district to the other.

Comparing the results of the various reports, it must be admitted that both systems, namely, the control of the inspection by numbered plates or equivalent means, and the plan of trusting in the men and offering the latter premiums for attention to their duties, have their advantages, and it becomes difficult to determine which of the two systems is the best. For controlling the inspection, the system of putting a plate or ticket on a post at the end of the district, as a proof at which time the last inspection took place, may be said to have given satisfactory results.

THE DIAGRAMMAGRAPHE.

(*Concluded from page 385.*)

In our former article on M. Pichault's "diagrammagraphe" we described the construction of the apparatus, and explained the principle upon which its action is founded, and we have now to add some particulars respecting the most convenient course to follow in employing the instrument to determine the action of any particular valve gear. In doing this we shall have to again refer to the illustration on page 386 of our last number but one.

The manner in which any particular link motion can be "mounted" in the apparatus has been already explained, and we will suppose therefore that the various parts have been already adjusted to represent the particular valve gear, the action of which it is desired to investigate, and that a disc of paper has been secured to the plate, *l*, Figs. 1 and 3. To commence with, the bar, *i*, is disconnected from the valve, and the tracing point moved by hand across the paper disc to ascertain that it passes exactly from zero to 180° of the divided circle, its doing so being an indication that a line drawn by it would pass through the centre of what represents the driving axle. If it does not do so the guides, *g*, are to be adjusted (the bolts which hold these guides passing through enlarged holes, so as to allow this to be done) until the desired result is obtained. At the same time it must be ascertained that the rod, *i*, moves freely, yet without shake, in the guides, *g*, and that all other parts of the apparatus move without jar or undue looseness. Any tendency of the sliding block to stick in the expansion link, or of the slide valve to move by jerks between its guides may be removed by the application of a little dry soap.

Next, the apparatus being turned until the radius representing the crank is situated on the dead point the tracing point is charged with a coloured fluid, let us say red, for example, and a diametrical line is drawn on the paper disc by moving the tracing point across it by hand. Next the plate, *l*, is turned through an angle of 90°, and a second diametrical line is then drawn by the tracing point at right angles to the first. During these operations the rod, *i*, must either have been disconnected with the slide valve or the latter must have been disconnected from its driving gear. The latter can be easily done by raising the sliding block from the expansion link, and we shall suppose this course to have been adopted.

The diametrical lines being drawn on the paper disc, the block is to be replaced in the link and the length of the valve spindle adjusted so that the valve gives equal lead at the commencement of each stroke. This can be done with the motion in full gear, or, as is sometimes preferred, with the block occupying a position in the link corresponding to the notch in which the engine for which the valve gear is intended, is generally run. This adjustment being made the apparatus is turned until the valve is at the middle of its stroke and the block is then again lifted out of the link and the plate, *l*, turned completely round, the tracing point being allowed to rest on the paper. By this means there is drawn on the latter the circle which we called, when explaining the principle of the apparatus, the datum circle. In like manner by placing the valve in the positions which it occupies when the front and hind ports are respectively just being opened to steam, there can be drawn upon the paper other circles distant from the datum circle (one within and one without the latter) by the amount of the outside lap of the valve. If the latter has inside lap or clearance, there are also to be drawn two other circles distant from the datum circle by the amount of such lap or clearance, the valve in these cases being placed in the positions which it respectively occupies when the front and hind ports are just on the point of being uncovered to the exhaust.

FIG. 17.

These preliminary lines being drawn the tracing point is next to be charged with ink of another colour, say blue, and the sliding block being replaced in the link, the apparatus is to be turned so as to allow the tracing point to describe on the paper the curve representing the motion of the valve. Such a curve, taken by the aid of a diagrammagraphe from a locomotive valve motion in full gear, is shown in Fig. 16 on page 430, the annexed Fig. 17 representing the valve used. The facts concerning the distribution of the steam received by the diagram reproduced in Fig. 16 will be easily read off after the explanation of the principle of the apparatus, which we gave in our former article; but there is one feature in it which renders it a somewhat exceptional specimen, and respecting which, therefore, it may be advisable that we should say a few words here. Referring to the diagram, it will be seen that besides the usual spaces marking the opening of the valve for the admission of steam (these spaces being distinguished by cross lines), there are two other spaces similarly marked, situated one without and one within the simple diagram. These spaces record the opening for the admission of steam afforded by the passage formed in the valve, this valve being of the Allen, or Trick type. Thus when this valve is moved from the centre of its stroke by an amount exceeding the outside lap, it not only admits steam in the usual way, but also allows an additional supply to enter the port through the passage cast in the valve, as shown in the section, one end of this passage—when the valve is moved as supposed—opening into the port which is receiving steam, while the other to a greater or less extent overhangs the end of the valve face. These additional portions of the diagram have been obtained simply by shifting the position of the tracing point on the rod, *i*, the circular lines which bound the spaces representing the action of the supplementary passage being drawn with the tracing point in the positions just referred to, and with the valve occupying the position in which the supplementary passage is just on the point of being uncovered for the admission of steam, and is just closed.

In his memoire on the diagrammagraphe, which has appeared in the *Annales Industrielles*, M. Pichault has entered at some length into a description of the mode of using the apparatus in designing valve gears; but we think that the explanation which we have already given of the principle and construction of the apparatus will be sufficient to show to all accustomed to designing such gears that the arrangement is one eminently adapted, from the ease with which it can be adjusted and the facilities it affords for changing the form and dimensions of its parts, for carrying out such investigations as the designing of valve gear requires.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig Iron Market.—During the latter part of last week there was a marked upward tendency in the prices of warrants, and on Tuesday, when business was resumed, there was great animation, and prices went up to 72s. and 72s. 6d. cash, closing a little easier. The quotations for makers' iron at the end of the week were: No. 1 Gartsherrie, 86s.; No. 1 Coltness, 85s.; No. 1 Calder, 84s.; No. 1 Summerlee, 82s. 6d.; Ardeer and Glengarnock, 81s.; Langloan and Shotts, 80s.—prices which are generally about 20s. in advance of those paid at the beginning of April; yesterday, however, the feeling was so strong to another advance, varying from 1s. to 3s. per ton, was made by nearly every maker. The market closed quiet to-day, the prices for warrants being at first 72s. 3d. cash, and then afterwards strong up to 72s. 9d. cash and 73s. 6d. a month, closing buyers at the best, sellers 1d. per ton more. Great demands are being made from England upon the Scotch makers, but as the latter have no stocks on hand they are quite unable to take orders for early delivery; and even in order to meet local wants large demands are being made on the stocks in public stores. Several thousands of tons have been withdrawn from Messrs. Connal and Co.'s stores since the beginning of the present month. Taking makers' stocks, together with those in public stores, it is probable that the statistics for the year will show a reduction of from 180,000 to 200,000 tons. Last week's shipments were: Foreign, 4211 tons; coastwise, 5469 tons; total, 9670 tons, as against 7246 tons in the corresponding week of last year. The total im-

ports from Middlesbrough up till Saturday last were 76,918 tons, as against 68,074 in the corresponding period of last year, the increase being 8844 tons. This increase was much larger a couple of months ago, but owing to the increased demand and shortness of supply in England the quantity sent into Scotland is weekly decreasing.

H.M.S. Hydra.—Messrs. John Elder and Co., of the Fairfield Shipbuilding Yard, purpose launching, this week, H.M.S. Hydra. She is an armour-clad turret-ship, 225 ft. long, 45 ft. broad, 16 ft. depth of hold, and 2107 burthen O.B.M. At her load-draft she will draw 15 ft. 9 in. This ship is one of four armour-clad turret-rams which were ordered by the Government during the late Franco-Prussian war, and is intended for coast defence, having a shallow draft of water, with a free-board of only 3 ft. 6 in. The sides are protected by 8 in. armour above, and 6 in. armour below the water-line, fitted upon teak varying from 10 in. to 12 in. thick; this belt is 7 ft. wide, and both armour and backing taper towards the extremities. The turrets are two in number, constructed of two thicknesses—of 4 in. plates, and protected by armour plates 10 in. and 9 in. thick—fitted on backing 9 in. and 10 in. thick. Each turret carries 18-ton guns, firing projectiles weighing 400 lb., and containing 62 lb. of powder each discharge. These turrets can be turned not only by steam engines, but also by hand, in the event of the former breaking down or being damaged. The Hydra will be propelled by twin screws, worked by engines of Messrs. Elder's compound principle of 250 nominal horse power. Being divided into upwards of 50 water-tight cells, and having the two bottoms as used in H.M. navy, every precaution has been taken to render her buoyant in case of accident, and otherwise adapted for the defence of our coasts and seaports.

Institution of Engineers and Shipbuilders.—At a meeting of the Institution of Engineers and Shipbuilders in Scotland, held last week, the Rev. Mr. Kilnor, of Chester, exhibited and explained models of his inventions of his grab-link, as applied to the lowering of lifeboats from ships, and as a self-acting stopper for chain cables, so that the cable can be veered out link by link; also, his method of propelling vessels in calms. The members expressed themselves highly pleased with the ingenious and effective contrivances exhibited.

Association of Engineers in Glasgow.—The usual intermediate meeting of this association was held last week, the President, Mr. John Sutherland, in the chair. After a number of new members had been admitted, a discussion took place on "Electro-Deposition," more particularly relating to the coating by that means of iron tubes with copper for locomotive and marine boilers. The subject was discussed, and the members expressed their views with regard to it in a manner which elicited much interesting and useful information.

Fairfield Association.—The usual fortnightly meeting of this association was held on Thursday evening, the President, Mr. Anderson, in the chair. An animated and lengthened discussion on "Screw Propellers," took place, the merits and demerits of the principal varieties being freely entered into. A vote of thanks to Mr. Anderson closed the proceedings.

Railway Sleeping Accommodation.—There has lately been exhibited at the Caledonian Railway Station a new form of sleeping carriage, which has been invented by Mr. James Howlinson. It is remarkably well adapted for night travelling. Externally, the carriage is exactly the same as those in ordinary use; its length is 33 ft., or about 2 ft. longer than the common carriage. Internally, the compartments while in use during the day do not differ in any respect from others, but when night comes on the arm-rests in the first-class compartments are raised, and thus two beds are provided, while above what seems the partition of the carriage is lowered on each side, and other two passengers are accommodated for the night. These upper berths, which are provided with pillows, resemble somewhat the "bunks" in use at sea. They are supported on brass rests fitted into the sides of the compartment, and are further secured by chain straps depending from the roof, by way of giving a feeling of additional security to sleepers. The carriage in question has been in use during the past month between London and Cambridge, and is now in Glasgow for the inspection of local gentlemen.

Dundee Water Commission.—It is said that "in the multitude of counsels there is wisdom;" but there is another wise old saw which says that "too many cooks spoil the broth," and of the latter there is a modern instance in the proceedings of the Dundee Water Commissioners yesterday. First, Mr. J. F. Bateman surveyed the ground and the proposed source of the additional water supply; then the Commissioners could not agree upon the route selected; Mr. Bateman was dismissed, and Messrs. Leslie and Stewart were engaged to devise a scheme; and at their meeting yesterday the Commissioners resolved to appoint a *fourth* engineer for the purpose of passing judgment and reporting upon all the plans. They did not name an engineer who would be likely to do such a thing, but they wisely resolved to bring in 8,000,000 gallons at the first rather than 5,000,000, as suggested by the special committee.

HALIFAX, NOVA SCOTIA.—It may, perhaps, excite some surprise when it is stated that the assessed value of property in Halifax, Nova Scotia, has been officially returned as follows: for 1871-2: real estate, 10,432,000 dols.; personal estate, 6,846,306 dols.; total, 17,278,306 dols.

THE AMERICAN IRON TRADE.—It is announced that ten new furnaces will be built on the line of the Schuylkill Navigation during the ensuing season, "under the auspices of the Southern Pennsylvania Iron and Railroad Company aided by the Reading Railroad Company." This is important, if true; the measure indicated will add indirectly to the value of Schuylkill coal properties.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Bradford Sewage Works.—The various measures in connexion with the new sewage works at Bradford are being pushed on as rapidly as possible in that portion of the valley between Frisinghall and Bolton Bridge. The course of the beck, or small stream, is to be straightened, and timber is being cut down along the intended route of the sewage operations. The main drain has been carried to within a short distance of Frisinghall, and a proper outlet has been made for its communication with the new works. In case of an unusual flush of water down the present main drain, it will be run off by means of a larger outlet into the beck. The course of the sewage works is in a direct line from Frisinghall to Bolton Bridge. Plenty of clay is found in the valley, and it is being extensively utilised for bricks all along the route. In excavating for the sewer, the men have come across an old road which has a paved causeway, and very fairly constructed roadway for vehicles. Mr. A. Neill, of Bradford, has the contract in hand.

Bradford Canal.—The company owning the canal between Leeds and Bradford are having its bed thoroughly cleaned out and repaired, wherever requisite, previous to the re-opening of the navigation between Shipley and Bradford, which is at present suspended.

Sheffield Water Works Company's Reservoirs.—The new Dam Flask reservoir embankment and the work generally in connexion therewith is being rapidly pushed on. When finished the Dam Flask reservoir will be of great service to the company and will very materially augment their storage capacity. It is understood that the Strines reservoir of the same company is in a complete state, or nearly so, and is filling with water.

Price of Coal and Colliers' Wages in Yorkshire.—At a meeting of West Yorkshire coal owners held at the Queen's Hotel, Leeds, on Wednesday it was resolved to raise the prices of all kinds of coal 1s. per ton. On Friday last a meeting of South Yorkshire colliery proprietors was held at the King's Head Hotel, Barnsley, to consider the application of the men in the district for an additional 5 per cent. Mr. Stewart, of Lund Hill, occupied the chair and there were present Mr. Pope, of Denaby Main; Mr. Dymond, the Oaks; Mr. Huntriss, of Darfield Main; Mr. Blythe, of Wombwell Main; Mr. Beecher, Lund Hill; and most of the leading coal owners in the district. Messrs. John Normanseil and P. Casey attended on behalf of the men. After a friendly discussion, it was agreed to concede the 5 per cent. on and after the first pay day in January. This concession will benefit some 14,000 colliers.

Proposed Purchase of the Sheffield Water Works Company.—It is stated that the Bill of the Sheffield Corporation to compel the Water Works Company of that town to sell their undertaking, is not to be proceeded with, the usual notices in November having been given as a precautionary step in case the company went to Parliament.

Prevention of Fraudulent Trade Marks.—At the Cutlers' Hall, Sheffield, on Friday last, an important meeting was held relative to the question of foreign goods bearing English trade marks being imported into this country. The committee representing both the Chamber of Commerce and the Cutlers' Company, conferred with Mr. Mundella, M.P., and it was stated that a case of German cutlery had been recently seized by the customs officials in London on their finding that the goods were fraudulently marked. Mr. Thomas Turner (the master cutler) presided, and after a lengthy discussion it was resolved to appoint a deputation to wait upon the President of the Board of Trade to urge the propriety of introducing an amendment into the Customs Consolidation Act, to remedy the defects in the existing Act as to the seizure of goods improperly marked. Mr. Mundella undertook to arrange with Mr. Chichester Fortescue for the interview, and also to consult the Solicitor-General of Customs on the subject.

The Improvement of Leeds Bridge.—The arbitration on the property of Mr. Emsley agreed to be purchased by the Leeds Corporation for the improvements in connexion with the new bridge, was concluded on Thursday evening last, so far as the bearings are concerned. Mr. Richard Southwaite of Lumby, was appointed sole arbitrator. The property consists of some shops and warehouses at the back. Mr. Shaw for the claimant said the corporation had agreed that the compensation should include the value of the property, Mr. Emsley's interest in the bed of the river Aire and compensation for contractors trespass in erecting the new bridge. Two witnesses for Mr. Emsley estimated the value of the property at about 10,900*l.*, but witnesses on the other side assessed its value at about 6300*l.* The arbitrator reserved his decision and will shortly give it.

Sanitary Work in Leeds.—From the report of the Leeds Streets, &c. Committee, just issued, it appears that during the past year 449 syphon traps have been constructed, and 278 open water gullies. 101 streets had been paved and flagged, measuring 5 miles 7 furlongs and 111 yards. Total cost of sewerage works (including both mains and branches) 2364*l.* The total cost of paving and flagging and sewers during the year is 23,584*l.* 10,000*l.* has been expended on experimental sewage works at Knostrop for dealing with 2,000,000 gallons per day, which, if successful, will form part of permanent works. The whole of the work has been carried on by Mr. Alfred Fowler, C.E.

Bradford Chamber of Commerce.—A special meeting of the Bradford Chamber of Commerce was held yesterday for the purpose of considering what subjects should be considered at the annual meeting of the associated chambers. Mr. Jacob Behrens presided. The Council decided to memorialise the Secretary for India on the question of a better representation of commercial interests in the Indian Council. The Chamber also decided, after a somewhat lengthy discussion of M. Thiers's speech, to memorialise the Foreign Office, calling attention to that part of M. Thiers's message which referred to undervaluation, stating that it was the interest of the British merchant that all should be treated alike, and that the Chamber offered their co-operation to render the Government able to enforce the payment of the duties.

FOREIGN AND COLONIAL NOTES.

Baltimore and Ohio Railroad.—The directors of this undertaking propose to extend the line to Chicago. The engineer in charge has made a report of his surveys of the proposed route, which runs westward from Tiffin in Ohio to Lake Station on the Michigan Central Railroad near the southern extremity of Lake Michigan. The entire distance from Tiffin to Lake Station is 212¼ miles, and the cost of construction is estimated at 2,067,076 dols. or 16,114 dols. per mile.

Canadian Pacific Railway.—Intelligence has been received from several of the Canadian Pacific Railway surveying parties who are to be out all winter. They have been amply provided for by the supply officer, and will push on the work before them with the utmost despatch.

Canadian Steam Navigation.—It is understood that the Quebec and Gulf Port Steamship Company have made arrangements to put two additional steamers on the route between Montreal and the maritime provinces next summer. It is the intention of the company to employ a steamer regularly between Montreal and St. John's, Newfoundland, calling at Sydney and other ports in Cape Breton. A commencement has been made in this direction during the past season, the screw steamer Alhambra having made three trips to St. John's.

The French Iron Trade.—The chief difficulty experienced by the French iron trade just at present continues to be the sluggish delivery on the railways of raw materials, such as coal and pig. The Fourchambault Forges and Foundry Company has been compelled to temporarily suspend its operations from this cause. The publication of the *Bulletin du Comité des Forges de France* has been resumed; the last previous number which had appeared was issued in August 25, 1870.

Coal at Boston.—The receipts of anthracite coal at Boston, U.S., to December 2 this year amounted to 547,552 tons; of Cumberland, to 213,414 tons; and of foreign, to 92,000 tons. The corresponding receipts in the corresponding period of 1870 were: anthracite, 551,201 tons; Cumberland, 198,778 tons; and foreign, 95,818 tons. The receipts of anthracite thus showed a decrease this year of 3649 tons, while those of Cumberland increased 24,641 tons. The receipts of foreign coal will be seen to have decreased this year to the extent of 3817 tons.

Megantic and International Railway.—A meeting of the directors of this line has been held in Montreal, and a contract has been entered into with contractors of means and experience, for the construction of that portion of the line between Lennoxville and Bury. Already, it is stated, that a considerable amount of preliminary work has been done.

A German Experimental Squadron.—The fitting out of a German experimental squadron for the Atlantic is advancing rapidly. The cruise will last, according to report, for three years. The command is expected to be conferred on Vice-Admiral Jackmann.

Union Pacific Railroad.—The net earnings of the Union Pacific Railroad Company have been making good progress of late. They amounted in the first ten months of 1871, to 3,345,449 dols., against 2,242,963 dols. in the corresponding period of 1870.

The Nine Hours' Movement.—The New York Central Railroad Company has reduced the working hours of its employés to nine hours per day. The wages of the work people to whom this apparent boon has been conceded, have, however, been reduced in proportion.

Canadian Cities.—The population of the principal Canadian cities has been returned this year, as follows:—Montreal, 107,225; Quebec, 59,699; Toronto, 56,092; Halifax, 30,000; St. John, New Brunswick, 29,303; Hamilton, 26,716; Ottawa, 21,545; London, 15,826, and Kingston, 15,826. In 1861, the corresponding figures stood thus:—Montreal, 90,323; Quebec, 51,109; Toronto, 44,821; St. John, 27,317; Halifax, 25,028; Hamilton, 19,096; Ottawa, 14,669; Kingston, 13,743, and London, 11,555.

Belgian Rails.—Belgian metallurgical and mechanical firms are continually chuckling over the easy victories which they are achieving in Germany. Thus the house of Wendel has, obtained a contract for 2000 tons of rails, for a line from the East German to Bromberg. Part of these rails are to be delivered in July, and part in September, 1872. The Turkey in Europe Railway Company has also ordered 9200 tons of rails from MM. Blondiaux and Co., of Thyle-Château. Altogether, the demand for Belgian rails appears to be increasing.

Railroad Progress in the United States.—In 1860, the population of the United States was 31,434,466, and the length of railroad in existence was 31,769 miles, giving about one mile of line to every 1,000 inhabitants. In 1870, the population of the great Republic was 38,538,180, and at the close of the year, the length of railroad in existence was 54,335 miles, giving one mile of line to every 700 inhabitants.

German Rolling Stock.—Germany is suffering almost as much as France and Belgium from the want of rolling stock. In Austria, also, there are complaints as to the difficulties experienced in obtaining adequate supplies of coal. Surely continental capitalists cannot fail to see that they would derive large profits from applying themselves to the construction of rolling stock on a far larger scale than that on which it is at present produced.

RECENT PATENTS.

The following specifications of completed patents are all dated within the year 1871; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

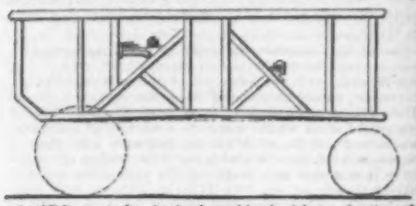
(No. 154, 10d.) James Edwards Wilson, of Spring-gardens, patents fitting traction engines with what he is pleased to term "circular travelling rails," these being enormous hoops which bear upon the road, and within which are rails on which the driving wheels of the engine run. Besides the driving wheels other wheels also bear against the interior of each hoop, the engine being carried by the latter alone, and there being no third wheel resting on the road to prevent pitching. A very slight practical experience with an engine constructed on these plans would, we think, be sufficient for most people.

(No. 155, 2s.) Robert Turnbull, of 4, Knapp-road, Bromley-by-Bow, patents modes of constructing pontoons for raising vessels. We cannot describe these plans briefly, but they appear worthy of attention.

(No. 160, 4d.) James Cartmell Ridley, of Albert-terrace, Jesmond-road, Newcastle-on-Tyne, patents adding to molten iron in the puddling or converting furnace, and at an exceedingly high heat, a certain regulated proportion of lead or oxide or salt of lead. The object is stated to be to improve the character of the iron obtained; but it is not clear how this improvement is to be produced.

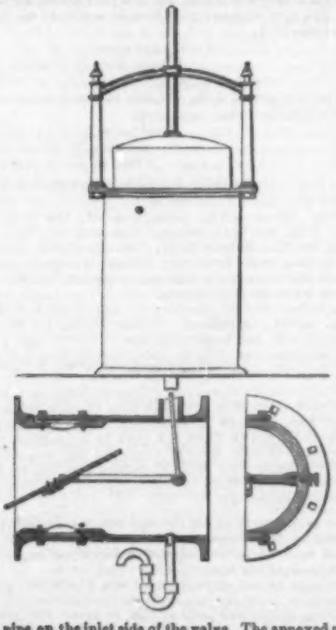
(No. 164, 1s. 2d.) Alexander Kirk Rider, of New York, patents arrangements of air and gas engines, which we could not describe briefly. We may perhaps illustrate one of these engines in a future number.

(No. 165, 6d.) Nathaniel Clayton and Joseph Shuttleworth, of Lincoln, patent making thrashing and winnowing machines with frames trussed in the manner described by us in our account of the Wolverhampton Show in July last (*vide* page 42 of the present volume). The annexed sketch shows the arrangement which enables a very strong



and stiff frame to be obtained combined with a reduction of weight.

(No. 166, 8d.) Charles Hunt, of Nine Elms, patents regulating the distribution of gas by means of an ordinary throttle valve mounted on centres within the pipe through which the gas passes, and actuated by a rod attached to a bell similar to that of an ordinary gas governor, this bell rising and falling in its tank according to the pressure of gas



in the pipe on the inlet side of the valve. The annexed sketch will explain the arrangement, which is very simple.

(No. 178, 6d.) William Cochrane, of Elswick Colliery, Newcastle-on-Tyne, patents, as the agent of Théophile Guibal, of Mons, Belgium, an arrangement of annemometer for measuring the velocity of currents of air in mines, &c. This instrument consists of a vessel containing a liquid, and mounted on a centre, so that it can be caused to revolve by the action of the current of air to be measured, upon vanes fixed to its circumference. As the vessel revolves, the centrifugal force causes the liquid which it contains to rise at the sides, and to be depressed in the centre, and the amount of this depression, which indicates the speed at which the vessel is revolving, is measured by a suitable arrangement of syphon gauge.

(No. 175, 1s. 10d.) Ferdinand Tommasi, of 166, Fleet-street, patents working hydraulic presses by alternately expanding by heat, and contracting by cold, the liquid contained in them. M. Tommasi's apparatus appears to be merely a complicated contrivance for attaining an end which can be arrived at in a more satisfactory manner by simple known means.

(No. 188, 8d.) Joseph Blackmore, of Manchester, patents making water cisterns for dwelling houses, of glazed earthenware. If such cisterns can be produced of the requisite size at anything like a moderate price, they will be admirably suited for their purpose.

(No. 193, 1s.) Charles Ferdinand de Kierakowski, of Great George-street, patents the arrangement of railway buffing and draw-gear, illustrated by us on page 14 of our last volume.

(No. 204, 2s. 4d.) Vaughan Pendred, of Crohill House, Milton-road, Dulwich, patents a great variety of forms of elastic wheels for traction engines, which it would be impossible for us to describe briefly.

(No. 201, 10d.) Robert Porter and Thomas Lane, of 172, Fenchurch-street, patent apparatus for making illuminating gas from oil or other liquid hydro-carbons, the patent also including arrangements of vertical retorts to be used in manufacturing gas from coal, &c.

(No. 207, 10d.) William Windle Pilkington, of St. Helens, patents arrangements for facilitating glass blowing. The objects of this apparatus are to support the glass-blower's tube and the glass attached to it; to enable the blower to impart the necessary swinging motion with comparative ease; to impart rotary motion to the glass and tube by mechanical means; and to effect, when desired, the blowing by mechanically compressed air.

(No. 218, 1s. 6d.) Samuel Wills Norman, of Oakley-street, Lambeth, patents arrangements for steering tramway cars by applying a brake to the leading wheel on that side towards which it is desired that the car shall turn. This system would only be of use in cases where the wheels on the two sides of the car are so mounted on their axles as to be capable of revolving independently. The patent includes some complicated arrangements of brake gear, which we need not attempt to describe here.

(No. 223, 10d.) Henry Bessemer, of Queen-street-place, Cannon-street, patents the apparatus for discharging marine artillery, which we illustrated and described on page 205 of the present volume.

PICHAULT'S "DIAGRAMMAGRAPHE."

(*For Description, see Page* 428.)

A Great Bridge for Turkey.—A Belgian firm, MM. Finet, Charles, and Co., has obtained an order from the Turkey in Europe Railway Company for the construction of a great bridge over the Maritza. The bridge will be 1338 ft. in length.

The United States Mint.—The director of the United States mint has issued his report for the year ending June 30, 1871. It appears that the coinage effected during the twelve months was as follows: Gold coin, number of pieces, 1,120,916, of the value of 21,302,473 dols.; gold bars, 13,101,089 dols.; silver coin, pieces, 3,664,792, of the value of 1,956,905 dols.; silver bars, 3,544,180 dols.; nickel, copper, and bronze pieces, 11,672,760, of the value of 283,760 dols.; total number of pieces struck 16,458,458; total value of coinage 40,187,409 dols. The director expresses an opinion that in consequence of the discoveries constantly being made of deposits of the precious metals in the Western states and territories it is probable that before another decade the annual production of gold and silver in the United States will be more than doubled. He considers, however, that the productive capacity of the mint and its branches is amply sufficient for the present.

The Port of Brindisi.—The large steamers of the Peninsular and Oriental Steam Navigation Company have now their berths close alongside one of the quays of the inner harbour of Brindisi, where they can conveniently land mails, passengers, and what little cargo they may have. The following works were undertaken by the Italian Government in 1866 and were completed last year:—Two quays in the inner harbour 466 metres and 490 metres in length respectively; a boundary wall in the Canal d'Ingresso (or channel connecting the outer with the inner harbour); a breakwater 380 metres long, closing the Bocca de Puglie between the island of St. Andrea and the mainland; and a mole 280 metres long projecting to the east from Forte de Mare. The result of these works has been ample quay accommodation, the Canal d'Ingresso (or connecting channel) secured against land ships, the anchorage in the outer harbour protected, and the littoral current effectually prevented from bringing in deposits.

NARROW GAUGE ROLLING STOCK.

WE republish below the editorial article from the Chicago *Railroad Gazette*, in which our contemporary comments upon the letter addressed to it by Mr. Schuyler, and which we published last week. Our own remarks on the subject will be found on another page of the present number.

We fear that many of our readers are growing very tired of this subject. Its importance, however, and the letter of Mr. Schuyler, published in this number, seem to justify us in devoting some space—now sadly needed for other subjects—to the consideration of his arguments and the facts involved therein.

The difficulty in the discussion of this subject, which is the cause of endless misapprehension and misunderstandings, arises from the fact that in the comparisons of cost, &c., which are made, the conditions are not the same in both cases. If our opponents on this subject contend that a narrow-gauge road, with facilities inferior to those of a wide-gauge road for transporting passengers and freight will cost less than the latter, then they may discontinue the discussion at once, because we and all who agree with us will concede that much, if it is the only question at issue. That to which we are and have been addressing ourselves is, the difference in the cost of building, equipping and operating roads of say, 3 ft. and 4 ft. 8½ in. gauge, with exactly the same facilities—or as nearly as the difference of gauge will permit—for doing the same business on the same line. Of course, whatever advantages are inherent or are dependent upon the distance between the rails each may claim. For example, it is manifestly unfair that the weight of a car per passenger in which the seats are only 30 in. apart should be compared with that of one in which they are 32 or 33, or that a car having six-wheeled trucks and 30-in. wheels should be compared with one with four-wheeled trucks, unless the distance between the rails would give the small wheels an advantage on the one road which they would not have on the other.

In order to make this view of the case as clear as possible, we will suppose that a railroad is needed in a section of country with a small traffic and little capital. At the present time the question would at once arise, whether it would be best to adopt a wide or a narrow gauge. If now, persons interested in such a project should determine upon the facilities which the traffic of the proposed line would require, it would remove much of the ambiguity which ordinarily surrounds the question. We will suppose they have investigated the subject, and they have determined that their freight trains should run at an average speed of 15 miles per hour, and passenger trains 25 miles per hour; that the grades should be the same whether the road was wide or narrow; that if it was a 4 ft. 8½ in. gauge, the shortest radius of curvature should be 400 ft., and that the resistance per ton of train on the shortest curves of a 3 ft. gauge should not exceed that on a curve of 400 ft. of the wide gauge, the fact to be determined by actual experiment with a dynamometer when the road was completed. We name 400 ft., because curves of that radius were for a long time used on the main line of the Baltimore and Ohio, and other railroads, and were successfully operated. Of course any other radius, say 300 or 600 ft., could be stipulated, at the discretion of the parties interested. If they have sought information on roads which have used four-wheeled cars for general traffic, they will have learned that their use in this country in nearly every case either has been or is being abandoned, and therefore it would probably be stipulated that the cars should all have double trucks, of the ordinary American plan. The seats for passengers to be 18 in.

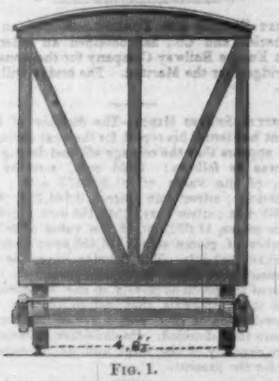


FIG. 1.

wide and 30 in. from centre to centre. Each car to have an aisle not less than 18 in. wide and a saloon 2½ by 3 ft. The proportion of floor area and cubical contents to the carrying capacity of freight cars to be the same as that of the cars on ordinary railroads, say the Pennsylvania. The greatest weight to be carried on one wheel of any vehicle not to exceed 5000 lb. The weight of rails to be determined by Rankine's rule, i.e., "the weight per yard to be 15 lb. for each ton of the greatest load on one wheel." If the adoption of the narrow gauge is taken into consideration at all, of course it is understood that cars of the ordinary gauge will not be required to run on the new line; if they were, the narrow gauge would be out of the question. Those stipulations could, of course, be modified to suit circumstances, but we will consider the respective advantages of a 3 ft. and 4 ft. 8½ in. road, upon the supposition that the same conditions are to be fulfilled by whatever gauge is adopted.

Having this clearly in our minds, let us see how the freight car for the Denver and Rio Grande Railway, described in Mr. Schuyler's letter, fulfils the conditions. A Pennsylvania railroad box car measures inside 26½ by 8 ft. wide, and is 6 ft. 3 in. high, which gives 1325 cubic feet of available space. It therefore carries 15 lb. to each cubic foot. The narrow gauge car has 690 cubic feet, and not 792 as Mr. S. has erroneously stated,* and therefore if it was rated at 15 lb. per foot would have a capacity of 10,300 lb. instead of 17,000. To say that "few articles of general traffic are so bulky in proportion to their weight that they would fail to load the car to its full capacity," is not a very exact statement, nor supported by any statistics or facts. Such articles as agricultural implements, boots and shoes, carriages, cotton, fruit, furniture, leather, live stock, hay, wooden ware, &c., all require at least a cubic foot of space for every 15 lb. of weight. Upon investigation it will be found, we think, that of nearly half the freight shipped in box cars, not more than 15 lb can be loaded per cubic foot, and that, therefore, if the size of cars is reduced so as to give only a cubic foot of space to 26 lb. of freight, practically their carrying capacity is lessened at the same time.

It is also obviously unfair to compare the weight of a car which gives a cubic foot of space to 15 lb. of freight with one which gives only the same space to 26 lb. If the Pennsylvania car were reduced in size it would weigh less; and if the Denver and Rio Grande car were made larger it would weigh more.

The proportion of dead to paying weight of the Denver and Rio Grande car, if its capacity were calculated for the same bulk of freight as the Pennsylvania car, would be 1 to 1.16, instead of 1 to 2. Considering that the cars on the Erie—6 ft. gauge—road weigh 18,500 lb., and carry over 21,000, or a proportion of 1 to 1.14, we do not see that the evidence furnished by the Denver and Rio Grande car, to prove that the proportion of dead to paying weight is reduced by narrowing the gauge, is very conclusive.

If the advocates of the narrow gauge system assume the position which has recently been taken by ENGINEERING, viz., that the dead weight of small cars is much less on the narrow gauge than on the broad, then we must ask what difficulty there would be in transferring the Denver and Rio Grande car body to the wide gauge trucks, as shown in Fig. 1 herewith; and if none, whether its weight would be increased by such a transfer; and if not, how much more the trucks would weigh for the one gauge than for the other? The proportion of the width of car body to that of the truck, as shown by the engraving, is not, we think, the best which could be devised, but would be very much improved by widening the former; nevertheless, if it be desirable that the width of car bodies should not exceed 6 ft., it can be run on 4 ft. 8½ in. trucks. If they were made 8 ft. wide and 16 ft. long, there would be the same floor area while the longitudinal floor timbers would be shorter, and could therefore be lighter, and the sides or walls of the wide car would be only 48 ft. long, instead of 56 ft. for the narrow one. The truss rods would also be shorter, and could be lighter, and have the same strength. The transom timbers and rafters should, of course, be made heavier, but it must be remembered that while they are lengthened only 2 ft., the longitudinal timbers are shortened 6 ft., and that when the car is shortened, only one of the two 3 by 9 in. "corbels" would be required.

A long and narrow car body is not an economical form of construction, because more weight is required to strengthen the longitudinal timbers than is saved in the transverse pieces, and also because a greater length of side or wall is required to enclose a given area of that form than if it approximates to a square.

Inasmuch as the width of 3 ft. gauge cars is confined within narrower limits than those for 4 ft. 8½ in. roads, to that extent is the former gauge a disadvantage. If, therefore, box cars with the same cubical capacity and strength as the one we have illustrated were required for a 4 ft. 8½ in. road, they could be built of the same, or possibly less, weight than for the narrower road, because they could be widened on the one and could not be on the other.

With reference to the weight of passenger cars, it may be remembered by some of our readers that in the article published in the *Gazette* of August 19 we gave the weight of the Denver and Rio Grande passenger car, as 15,000 lb. with seats for 34 passengers, which gave a weight of 441 lb. per passenger. We also described a car on the New Jersey Railroad which weighed 26,100 lb., and would seat 60 passengers, with the same space for each as in the narrow gauge car. This gave a weight of 435 lb. per passenger.

It may also be remembered that in the *Gazette* of September 23 we published a letter from the builders of the Denver and Rio Grande passenger cars, in which they stated that we "failed to mention whether or not the New Jersey car, like the narrow gauge car, has two saloons, a partition and a stove." We should not refer to this again, were it not that Mr. Schuyler has called attention to the same subject, and therefore we give herewith a plan of the two cars whose weight was compared. The one, Fig. 2, is that for the Denver and Rio Grande Road, and Fig. 3 the New Jersey car. In the latter the seats are arranged the same distance apart, and with two saloons, the same as in the narrow gauge car, without stoves. The one seats 36 passengers, and weighs 15,000 lb; the other seats 60 passengers, and weighs

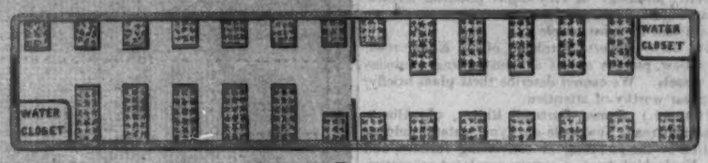


FIG. 2.

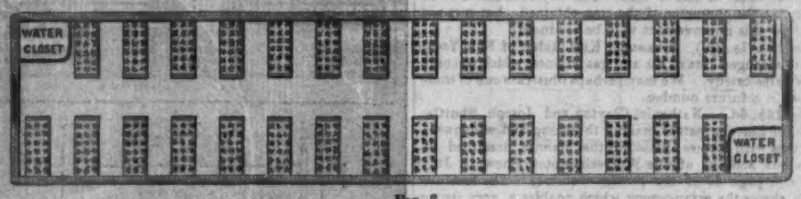


FIG. 3.

26,100 lb. The first, however, has four-wheeled trucks with 24 in. wheels, while those of the New Jersey car have six 30 in. wheels; therefore, in order to make the comparison entirely fair, the weight of four 30 in. wheels, which weigh 480 lb. each, and two axles, of 280 lb., with the springs, boxes, &c., should be deducted from the weight of the car. Their weight would amount to at least 3000 lb. Therefore the weight of car which should be used for the comparison would be 23,100 lb., or 385 lb. per passenger. It must also be remembered that the wheels under the wide gauge car are 20 in. in diameter, and weigh 480 lb., while those under the narrow gauge car are only 24 in. in diameter, and weigh 275 pounds, and therefore that eight of the large wheels are heavier in proportion to the weight they carry than the small ones on the narrow-gauge car.

Mr. Schuyler says that the car we have selected for this comparison "is in use only as a smoking car or second-class car." To determine this we wrote the following note to Mr. Barker, to which he made the reply which accompanies it:

George W. Barker, Esq., Master of Transportation, New Jersey Railroad and Transportation Company.

Dear Sir,—Will you inform me in what class of traffic car No 29—of which you were kind enough to give me the weight in your letter of August 12th—is or was then employed?

Yours respectfully,
EDITOR RAILROAD GAZETTE.

Editor Railroad Gazette.

Dear Sir,—Car 29 is in daily use on our local trains, carrying our regular first-class passengers.

Yours truly, &c.,
GEORGE W. BARKER.
Master of Transportation.

These cars, with the saloons as we have drawn them in the plan, will give as much comfort as, and would be preferred to those of the Denver and Rio Grande car by nearly all travellers. It is true they have some of them grown dingy from long use, and that their finish is not so ornamental as is all the work done by the Jackson and Sharpe Company; but the ornament adds very little, if at all, to the comfort of the travellers, or the weight of the cars.

Some of the other cars on this road give even less weight than the one we first referred to. Car No. 42, for example, weighs 27,400 lb. and would seat four more passengers than No. 29, and therefore, with the deduction for the four extra wheels and attachments, will weigh only 381 lb. per passenger.

It has also been said that nowhere else would we have found cars so "frail" as the one we cited. Now, if by "frail" our correspondent means light in weight, we might say that because we knew that the cars on that road are light, is exactly the reason we went there to get their weight; but if he means that the cars have not sufficient strength, then we have only to refer to the fact that twenty or more of them have been in use for half a dozen years on a road doing the heaviest passenger traffic in the country, which fact makes the statement that "light equipment for light head roads has been tried repeatedly in this country and abandoned" sound somewhat curiously.

In a comparison of the weights of cars it is entirely fair for the advocates of either system to take the lightest they can find for the gauge they advocate, and compare them with the cars of the same kind on the other gauge. When, therefore, we are called upon to compare a narrow-gauge smoking car with longitudinal seats with cars having transverse seats, we say the two cars are not of the same kind. We could select wide-gauge cars of that kind for comparison, and suggest those for the elevated railroad in New York.

If the argument so earnestly advanced by the advocates of the narrow gauge, that the amount of dead weight is reduced by placing the rails nearer together, is true, then it ought certainly to follow that the dead weight of the cars on a 6 ft. gauge would be more than on one of 4 ft. 9½ in. Now

* This arose from his calculations being made with the dimensions of the car outside of the studding, instead of inside.

we confess to a little surprise to find that the reverse is the case. In other words, while a box car for the Pennsylvania road weighs 19,000 lb. and is said to carry 20,000 lb., an Erie car weighs 18,500 lb. and carries over 21,000 lb.

Mr. Schuyler also calls attention to the fact that they load 21,000 lb. of railroad iron on two cars, which weigh 3500 each, or a proportion of dead to paying weight of 1 to 3. He says: "I should certainly like to see a train made up upon a broad gauge of any cars which would weigh so little and do so much as these." We accept the challenge, and submit the following account of the weight and work done by timber trucks built and used on the Baltimore and Ohio Railroad for carrying ship timber:

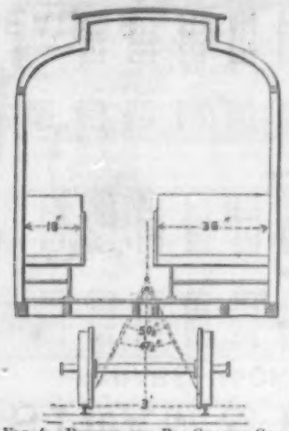


Fig. 4. Denver and Rio Grande Car.

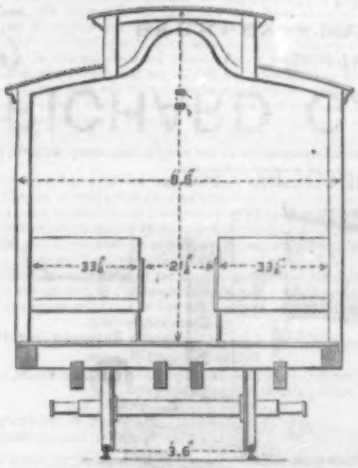


Fig. 5. Toronto, Grey, and Bruce Car.

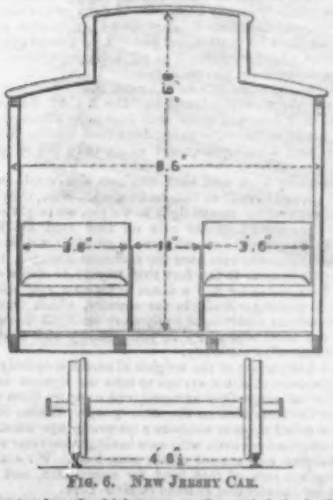


Fig. 6. New Jersey Car.

"The trucks of which you speak carried the load upon sixteen wheels. The two trucks weighed 11,000 lb. each (22,000), and they both carried a load of 60,000 lb., and I have known them loaded up to 80,000 lb."

We omit the writer's name because he has not authorised its use.

In order that a better idea may be formed of the proportions of cars for different gauges, we give herewith sections of some for 3 ft., 3 ft. 6 in., 4 ft. 8½ in., and 6 ft. gauges. They are all drawn to the same scale, so that a very good idea can be formed of their relative size.

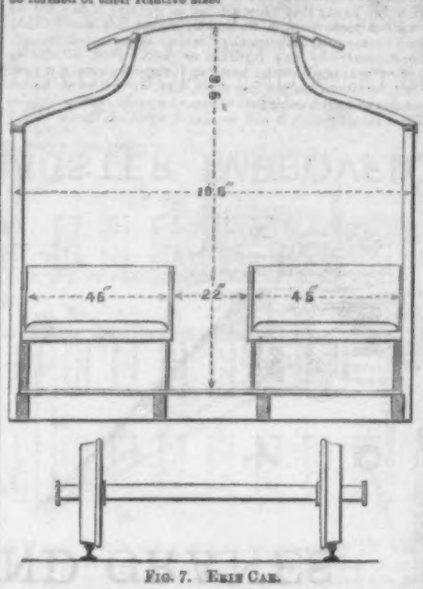


Fig. 7. Erie Car.

If the cars for the wide gauges were contracted in the width of seat and in the height of roof, the same as for the narrow gauge, considerable weight could be saved.

In this connexion we wish to call attention to the fact that the Erie car, which is 49 ft. 9 in. long, and 10 ft. 6 in. wide, and weighs 33,500 lb., will seat 67 passengers. Now if the seats were arranged for two on one side of the aisle and three on the other, and with the seats 19 in. wide instead of 18 in., and the same distance apart longitudinally that they are on the 3 ft. gauge, 87 passengers could be seated, with two saloons, and with more room for each passenger than in the narrow-gauge car, and with a dead weight of only 385 lb. per passenger.

Surely this is conclusive evidence, disproving the theory that the dead weight is reduced in proportion to the gauge. If a car can be made to have less dead weight per passenger on a 6 ft. gauge than for one of 3 ft., then it would seem as though the gauge had very little to do with the question.

There is an argument which is often used in favour of a narrow gauge, which, unfortunately, like many other errors, is easier stated than refuted. The reasoning is, that if a 4 ft. 8½ in. gauge is better than one of 6 ft., then one of 3 ft. must be better than 4 ft. 8½ in. Now this syllogism is very much like that of the unfortunate patient with his pills: "If," thought he, "one pill will do me good, then the whole box will cure me," and, forsooth, he took them all at one dose. If the reasoning proved anything, it would demonstrate that a single rail was the perfection of gauges.

It is also asserted by nearly all advocates of the narrow gauge that the resistance of cars in passing around curves is materially less on a track of which the rails are 3 ft. apart than on one in which they are 4 ft. 8½ in. apart. None of them, however, to our knowledge, have yet stated how much less the resistance is on the one road than on the other. It may be so little as not to be worth consideration. Will some of them enlighten us, because we very frankly admit that we do not know, but, at the same time, can see no reason why the gauge should have any effect upon the flange friction, to which our correspondent calls attention, and which, we believe, would practically be the same on any gauge, or on a single rail.

With reference to our estimates of cost, although our correspondent expresses a general want of confidence in them, yet he gives but one reason for the want of faith in him. We refer to the item of masonry. Now it may be as well for us to admit that we were not as explicit in that matter as we should have been. If the bridges are built wide enough to permit the running of ordinary cars over them, the cost of the masonry will be increased over that required for a narrow gauge. If, however, the cars to be run over them are of the same width as those on the narrow gauge there would be no difference in cost. Culverts must, of course, be longer for a wide-gauge track than for a narrow one. Their cost may or may not be included in that of grading.

The cost of engine-houses, car-shops, &c. will be no greater for the one road than for the other, if the one is built to do exactly what the other will do. If, however, you build a light road in such a way as to be able to run heavy cars on it, the cost will certainly be more, but then the comparison is no longer one of the cost of two roads to do the same work or to fulfil the same conditions. It must be remembered, however, that the light wide-gauge cars under any condition of things can be run on a heavy road, if desirable, which cannot be done with narrow-gauge cars; and also that, by a little extra expenditure, the wide-gauge road can be adapted for ordinary cars, but that no expenditure of money would do this with a narrow gauge.

Much of Mr. Schuyler's reasoning seems to be intended to establish the fact that when wide-gauge roads are built the tendency to run heavy rolling stock on them is so strong that it cannot be resisted, and such roads speedily become—what? Why, ordinary railroads! Now, if this tendency is so irresistible, there must be some good reason for it, and, therefore, whatever prevents obedience to it, instead of being an advantage, is an evil.

If, as we have taken occasion to remark in previous articles, a narrow-gauge road, to do any given service in a given way, can be built, as the advocates for it claim, for three-fifths the cost of a similar road of the ordinary gauge, then their case is proved, and there is nothing more to be said for the other side. The burden of the proof, however, is on their shoulders, and it is for them to show that they can build lighter cars, run shorter curves, climb steeper grades, build cheaper bridges, use lighter iron, and do less grading for their line than is required for a line with a wide gauge to do the same service. What we say is, that they cannot build cars which will weigh only three-fifths as much as cars of the same character for a wide gauge; neither can the curves be shorter, the grades steeper, the bridges cheaper, the iron lighter, or the grading less in anything like the proportion named.

We do not wish, nor is it necessary, to speak for the *Scientific American*. It is able to do that for itself. It has seen proper to agree with what we have said of the relative cost of wide and narrow-gauge roads, and, we suppose, did so for good and sufficient reasons, or what seemed such to its editors. At any rate, we feel quite sure that it was not because the idea expressed therein had the patronage of men of very great wealth or pecuniary influence.

LIERNUR'S PNEUMATIC SEWERAGE SYSTEM.

To the Editor of Engineering.

Sir,—I noticed in your number of 8th inst. an inquiry from a correspondent, signing himself "C. W.," about the working of Liernur's pneumatic sewerage system at the Hague. As representative of Captain Liernur in the Netherlands, I am happy to inform him, and any other of your readers that take an interest in the sewage question, that the system is in successful operation at Amsterdam and at Leiden, but not yet at the Hague.

At Amsterdam it is introduced in two different localities—the one containing 61 dwellings, the other being a row of uniform buildings belonging to a building association.

At Leiden it is introduced into four blocks, containing 131 dwellings. This part of the town was, before the application of the system, in the worst possible sanitary condition, a cholera epidemic causing the deaths of one-tenth of the population, and typhus making also many victims.

In laying the tubes for Liernur's system, the cause of this came to light; the existing sewers having been constructed in masonary had all gone to decay, thereby causing the percolation of organic substances into the soil, and into wells and cisterns.

Although there has been some trouble from malicious persons throwing objects into the privies to impede the working, the obstacles have been generally removed by the force of the pneumatic blast, as the system is so arranged that in case of obstruction, the whole force of a complete vacuum can be brought to bear upon a surface of a few square inches.

Besides, there are movable parts to all traps and valves, which can be reached from the floor or the pavement in order to remove any obstacles which resist the pneumatic blast. Of the difficulty apprehended by your correspondent that the pipes would become coated with an ever-increasing lining of filth, nothing has appeared, the pipes remaining, on the contrary, remarkably clean—only moist.

The privies are cleaned completely every day by the application of a pneumatic blast obtained from a vacuum: the engine and air-pumps are placed upon wheels, being pulled by a pair of horses from reservoir to reservoir, this being a temporary arrangement, since in case of a more extended application, stationary engines, placed in the outskirts of the town, will be used.

The removal of faecal matter will then take place entirely unperceived by anybody, except by those engaged in its removal from the town.

At Amsterdam the success has been so generally acknowledged that some parties applying for powers to build some blocks of houses made the following stipulations for additional works to be provided by the council, to which the council agreed—pavement of the streets, illumination by gas, and Liernur's system of sewerage.

I shall be happy to give to any of your readers that may desire it further information about the system, and to give them an opportunity for seeing it at work in case they should think it worth their while to visit Holland for the purpose.

For information in regard to plans and specifications, I beg to refer to Messrs. Liernur and de Bruynkops, civil engineers, 8, Eiserne Hand, Frankfort-on-the-Maine, who are the patentees of the system.

Yours respectfully,

P. Maas Geesteranus.

Leiden, December 17, 1871.

The Suez Canal.—The revenue of the Suez Canal Company in November amounted to 50,905*l.*, as compared with 21,927*l.* in November, 1870, showing the very substantial increase of 28,978*l.* The number of vessels passing through the canal in November was 66, as compared with 42 in November, 1870.

Mr. L. H. Moorsom.—We understand that the King of Denmark has lately conferred upon Mr. L. H. Moorsom, M. Inst. C.E., surveyor-general of Hong Kong, the order of the "Danebrog," for valuable aid in the promotion of Danish interests in the East, in connexion with the laying of the Great Northern, China, and Japan Extension Telegraph between Hong and Shanghai. Mr. Moorsom is one of the sons of the late Captain W. S. Moorsom, M. Inst. C.E.